

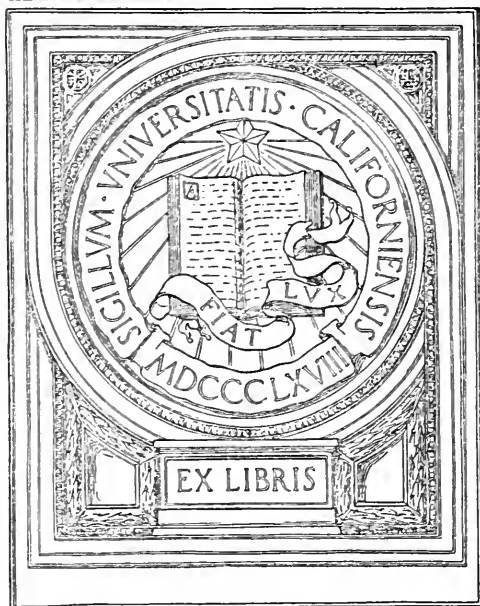
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METROPOLITAN WATER AND SEWERAGE BOARD

EIGHTEENTH ANNUAL REPORT

DECEMBER 31, 1918

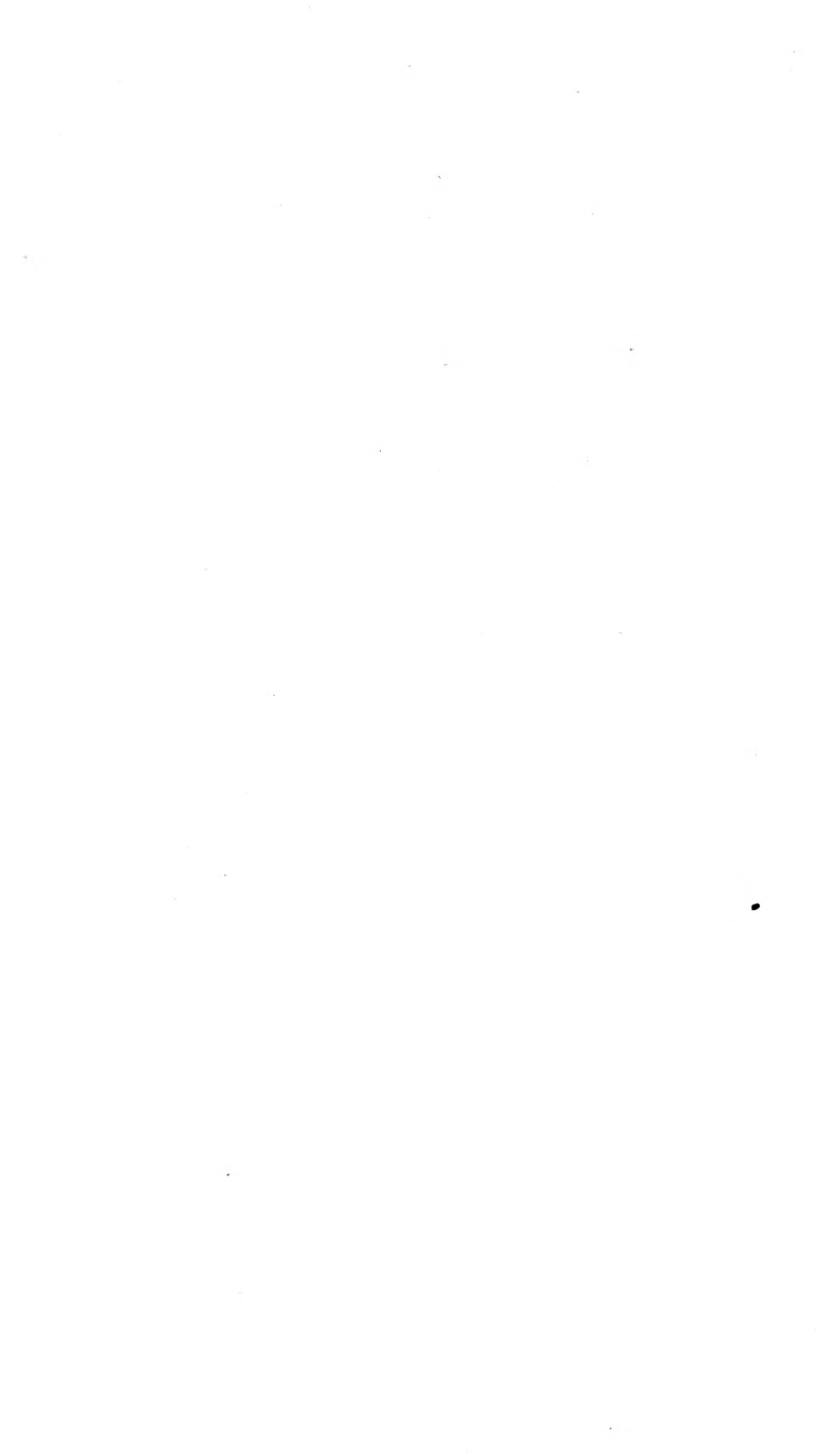
UNIVERSITY OF CALIFORNIA
AT LOS ANGELES



GIFT OF

W. CLOKE







STEEL TOWERS 68 FEET HIGH ON WACHUSETT-SUDBURY POWER TRANSMISSION LINE
AT SUDBURY RESERVOIR IN SOUTHBOROUGH.

EIGHTEENTH ANNUAL REPORT

OF THE

METROPOLITAN WATER AND SEWERAGE BOARD

FOR THE YEAR 1918



BOSTON
WRIGHT & POTTER PRINTING CO., STATE PRINTERS
32 DERNE STREET
1919

PUBLICATION OF THIS DOCUMENT
APPROVED BY THE
SUPERVISOR OF ADMINISTRATION.

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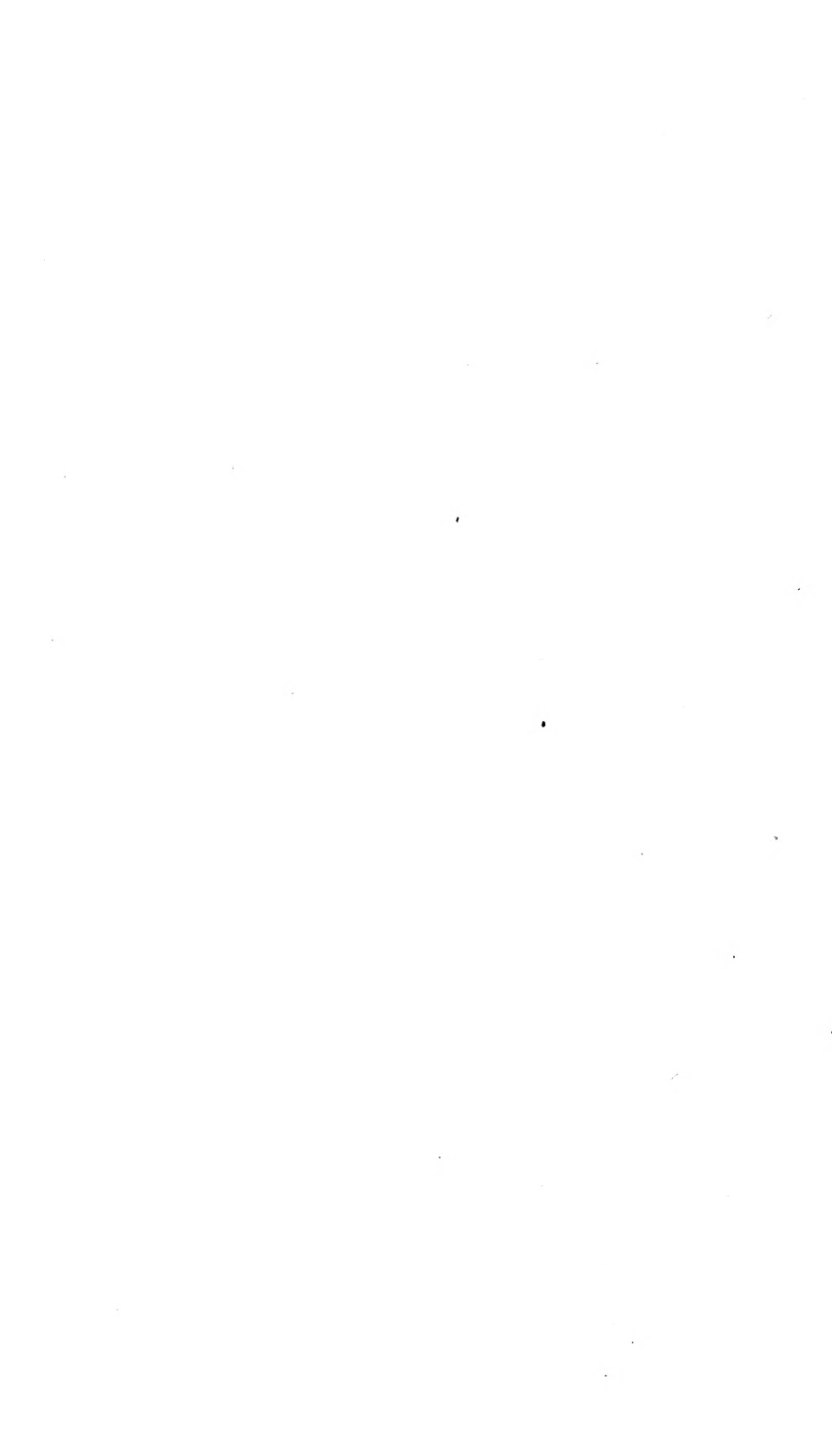
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METROPOLITAN WATER AND SEWERAGE BOARD.

To the Honorable the Senate and House of Representatives of the Commonwealth of Massachusetts in General Court assembled.

The Metropolitan Water and Sewerage Board, established under the provisions of chapter 168 of the Acts of the year 1901, has already presented to your Honorable Body an abstract of the account of its receipts, expenditures, disbursements, assets and liabilities for the fiscal year ending on November 30, 1918, and now, in accordance with the provisions of chapter 235 of the Acts of the year 1906, presents a detailed statement of its doings for the calendar year ending on December 31, 1918, being its

EIGHTEENTH ANNUAL REPORT.

I. ORGANIZATION AND ADMINISTRATION.

BOARD, OFFICERS AND EMPLOYEES.

The term of office of Thomas E. Dwyer expired on March 20, and James A. Bailey was appointed for the term of three years next succeeding. At the end of the year the Board consisted of Henry P. Walcott, chairman, Edward A. McLaughlin and James A. Bailey. William N. Davenport has continued as secretary. Alfred F. Bridgman has been the purchasing agent and Miss Alice G. Mason the bookkeeper.

There are also employed in the administrative office a paymaster, an assistant in auditing, a first clerk, two general clerks, two stenographers and clerks, a telephone operator, and a janitor with two assistants, both of whom act as watchmen.

Such general conveyancing work and investigation of real estate titles in the different counties as have been called for during the year have been performed by George D. Bigelow.

The consulting engineers of the Board are Hiram F. Mills and Frederic P. Stearns, who are called upon for services when matters arise which require their consideration.

William E. Foss is Chief Engineer of Water Works and John L. Howard, Assistant to the Chief Engineer. The following are superintendents of departments under the direction of the Chief Engineer: Eliot R. B. Allardice, Superintendent of the Wachusett Department; Charles E. Haberstroh, Superintendent of the Sudbury and Cochituate Works and of the portion of the Weston Aqueduct above the Weston Reservoir; Samuel E. Killam, Superintendent in charge of the Weston Reservoir and the remaining portion of the Weston Aqueduct, and of all distributing reservoirs and pipe lines within the Metropolitan Water District; and Arthur E. O'Neil, Superintendent of the several water works pumping stations.

The average engineering force employed on construction and maintenance during the year has included, in addition to the Chief Engineer, 1 assistant to Chief Engineer, 4 department superintendents, 1 division engineer, 7 assistant engineers and 26 others in various engineering capacities, and as sanitary inspectors, clerks, stenographers and messengers, the total force numbering 40.

A maintenance force in addition to those engaged in engineering capacities, as above mentioned, numbering upon the average during the year 285, has been required at the pumping stations, upon reservoirs, aqueducts, pipe lines and upon minor construction work. At the end of the year this force numbered 255.

Frederick D. Smith is Chief Engineer of Sewerage Works. He has been assisted by Henry T. Stiff, Division Engineer in charge of the office and drafting, by 4 assistant engineers and by 11 others employed in different engineering capacities, and by 2 stenographers and clerks.

The maximum engineering force employed at any one time during the year on the construction and maintenance of the Sewerage Works was 21.

The regular maintenance force required in addition for the operation of the pumping stations, the care and inspection of the sewers, and for other parts of the Sewerage Works, exclusive of the engineers and day-labor forces, on the average has been 149.

The whole regular force of the Sewerage Department at the end of the year numbered 165, of whom the Chief Engineer and 15 assistants and draftsmen were engaged in general upon the works, and of the remainder, 91 were employed upon the North System and 58 upon the South System.

The maximum number of men employed upon contracts and upon day-labor construction on the Sewerage Works during the year was for the week ending December 21, when the number amounted to 80.

II. METROPOLITAN WATER DISTRICT.

The Metropolitan Water District now comprises the cities of Boston, Chelsea, Everett, Malden, Medford, Melrose, Newton, Quincy, Revere and Somerville, and the towns of Arlington, Belmont, Lexington, Milton, Nahant, Stoneham, Swampscott, Watertown and Winthrop, — in all 10 cities and 9 towns. The District has an area of 174.8 square miles, no additional municipalities having been admitted into the District during the year. Its population, according to the State Census taken for April 1, 1915, was 1,201,300. The population of the District on July 1, 1918, the date upon which calculations for the Water Works are based, was estimated as 1,286,770.

III. METROPOLITAN WATER WORKS — CONSTRUCTION.

The total amount expended for the construction and acquisition of the Metropolitan Water Works since the passage of the Metropolitan Water Act in the year 1895 has been \$43,157,070.65.

The total amount expended during the calendar year on account of the construction and acquisition of works has been \$173,238.26. The details of this expenditure are as follows: mainly on account of work to provide for an additional water supply, from the southern high service of the Metropolitan Water System, for the towns of Watertown and Belmont, \$92,821.22; for work on account of the construction of the Wachusett-Sudbury transmission line, \$62,543.38; and for other minor works, engineering and administration expenses, the sum of \$17,873.66.

The construction of an electric transmission line from the Sudbury Dam power station to the similar station at the Wachusett Dam is now completed and the production of power at these two stations can for the future be used in the most advantageous manner.

The requirements of the United States Arsenal at Watertown and the rapid growth of other industries in that town have made necessary an enlargement of the water supply of the district comprised within the limits of Watertown and Belmont. Therefore, the Legislature, by chapter 177 of the General Acts of the year

1918, authorized the construction of an additional pipe line from the 36-inch high-service main in Commonwealth Avenue at Lake Street, Newton, through Brighton into Watertown and there connecting with the town pipes. The pipe line is 20 inches in diameter for a distance of 9,664 feet and is reduced to 16 inches in diameter for a distance of 503 feet to cross the bridge in the limited space available.

The contract for this work was at once made, was completed in October and the pipe line is now in use, at a cost well within the limits of the appropriation made for the purpose.

The work of bringing the Arlington pumping station to a condition sufficient to meet the needs of this rapidly growing district has necessitated the installation of a new pumping engine and this work has been completed during the year. With the exception of the limited capacity of the antiquated water tower on Arlington Heights and certain changes in connecting pipe lines, a sufficient provision for this district seems to have been made.

During the year the Board acquired easements in 0.078 of an acre of land in Southborough for the construction of the Wachusett-Sudbury transmission line, 0.006 of an acre for the maintenance of a wall of the coal pocket at Hyde Park pumping station, and 0.1181 of an acre in Brighton for the purpose of laying a water main for the supply of Watertown and Belmont.

In several directions very large expenditures for construction are still needed. The Board was reluctant to bring them forward during the recent troubled years but some of them are now submitted to the Legislature which of necessity must have a wider view of the whole situation than is possible for this Board. Additional pipe lines are needed for the better and safer supply of the District. These will require large amounts of money and the work will necessarily involve much time in its execution. Whenever the growth of the population makes imperative the use of all the sources of water now available some system of filtration must be established in order to maintain the satisfactory quality of the water now supplied. Consideration has already been given to this subject and preliminary plans have been suggested.

Some encouragement to large expenditures may be found in the fact that in this District water for domestic uses is the only article indispensable to man's life which has not been increased in price by the present disturbed conditions in the world.

In the minds of some not familiar with systems of water works there seems to exist an idea that when great works have been constructed the labors of oversight have ended. As a matter of fact they have then become most urgent. The State Board of Health in its report of 1895 upon a Metropolitan Water System very carefully stated the many problems which the coming water board would have to meet, and experience has shown that the statement was not overdrawn. In 1901 the consolidation of the Metropolitan Water Board with the Metropolitan Sewerage Commission presented new conditions of not greatly inferior importance.

It may be claimed with entire justice that the ability adequately to maintain complicated systems of water supply and sewage disposal requires qualifications not inferior to those of the men employed in the original construction however they may differ in character.

IV. WATER WORKS — MAINTENANCE.

The maintenance and operation of the Metropolitan Water Works during the past calendar year have required the expenditure of \$580,749.31.

(1) STORAGE RESERVOIRS.

The water in the Wachusett Reservoir reached its highest elevation, 393.50, on May 5, $1\frac{1}{2}$ feet below high-water mark. From that time the water subsided until it reached its lowest level of the year on December 13, at elevation 380.77.

The Sudbury Reservoir was at elevation 257.52, about $1\frac{1}{2}$ feet below the crest of the overflow, at the beginning of the year and was kept at least 1 foot below the crest until flashboards were put in place April 9. From July the water fluctuated above and below the crest until flashboards were removed on November 18. The water was then kept at about elevation 258 until the end of the year. During the winter the water in Framingham Reservoir No. 3 was kept below the crest of the overflow and during warm weather the water was kept near the crest between elevations 183 and 186. Water was drawn from Lake Cochituate for the water supply in January and February.

It has not been necessary to draw water for the supply of the Metropolitan District from Framingham Reservoir No. 1, Framingham Reservoir No. 2, Ashland, Hopkinton and Whitehall reservoirs.

(2) AQUEDUCTS.

The Wachusett Aqueduct was in service for the passage of water from the Wachusett Reservoir to the Sudbury Reservoir during the whole or portions of 298 days. The quantity of water flowing through the aqueduct was equal to an average of 108,667,000 gallons per day for the entire year, which is 18,547,000 gallons more than the daily average flow in 1917. All of the water drawn from the reservoir into the aqueduct was used before its admission for the development of electric energy.

For distribution to the cities and towns of the Metropolitan District water was drawn through the Sudbury Aqueduct to the Chestnut Hill Reservoir every day in the year, the daily average for the whole year being 74,633,000 gallons, an increase of 19,080,000 gallons per day over that discharged in 1917.

The Weston Aqueduct was in use 314 days, the quantity of water delivered through the aqueduct being equivalent to a daily average of 50,512,000 gallons, a decrease of 1,567,000 gallons from that delivered in the previous year.

Water was discharged through the Cochituate Aqueduct on 12 days during the year, the total quantity of water discharged being 154,400,000 gallons.

(3) PUMPING STATIONS.

The total amount of water pumped at all the pumping stations was 33,194,370,000 gallons, which is 9,586,350,000 gallons, or 40.61 per cent. more than in the previous year.

The following are the several pumping stations: —

	Number of Engines.	Contract Capacity per Day (Gallons).	Lift (Feet).
Chestnut Hill high-service station,	4	66,000,000	138
Chestnut Hill low-service station,	3	105,000,000	60
Chestnut Hill low-service station,	1	40,000,000	130
Spot Pond station,	2	30,000,000	125
Arlington station,	3	6,000,000	290
Hyde Park station,	2	6,000,000	140

The amount expended for the operation of the stations was \$194,390.98, which is \$59,175.23 more than for the year 1917.

The total amount of coal purchased during the year was 14,748.52 gross tons, of which 8,679.57 tons were bituminous and 6,068.95 tons anthracite. All of the anthracite coal was screenings. The average cost of bituminous coal delivered in the bins at the various stations varied from \$7.43 to \$8.75, and the average cost of anthracite coal varied from \$4.82 to \$5.99.

(4) PROTECTION OF THE WATER SUPPLY.

The Marlborough Brook filter-beds, on which is filtered the water received from brooks passing through the thickly settled portions of Marlborough still continue adequate for the filtration of the water received.

The Pegan Brook pumping station, at which is pumped upon the filter-beds the surface drainage of about one square mile in the thickly settled portion of Natick, was in successful operation on 215 days in the year.

The filter-beds which receive for filtration the water flowing through the thickly settled portion of the town of Sterling, as well as the smaller filter-beds which receive the drainage from a few houses near Sterling Junction, the Worcester County Training School at West Boylston and from the swimming pool at Southborough, have been in successful operation and required only the usual attention during the year.

Studies for the disposal of manufacturing wastes, as well as for the disposal of house drainage from the various towns within the drainage area of the Metropolitan Water System, have been in progress during the year.

Constant inspection of the watersheds has been maintained by the Sanitary Inspector and his assistants and members of the maintenance force. It is a well-earned tribute to the sanitary administration of the Wachusett water district that not a single case of typhoid has been found there during the past year.

Chemical examinations of the waters used were made by the State Department of Health, and in addition, microscopical and bacterial examinations were made by the Board. These examinations enable the Board to take measures to remedy any difficulties which are found to exist.

The quality of the water brought to the Metropolitan District continues to be satisfactory both in taste and appearance. This

condition results in a large measure from the fact that it is still possible to reject some of the sources which were in use before the extension of the water works to the South Branch of the Nashua River at Clinton. The water derived from the Wachusett watershed has been superior to that coming from the Sudbury and Cochituate sources. The first-named supply, so far as possible, has been that conveyed to the District; the others have been wasted to a greater or less extent as occasion has permitted.

The time, however, is approaching when all the sources will be required for the supply of the District. When that day arrives it will be necessary, without doubt, to filter these inferior waters in order to bring them to the standard of excellence to which the District has become accustomed since the establishment of the Metropolitan Water Supply.

During the year the Board acquired the fee of 28.75 acres of land in Boylston, 9.67 acres in Sterling and 2.44 acres in Northborough for the protection and improvement of the water supply.

(5) CLINTON SEWERAGE WORKS.

The Board has maintained and operated since September 15, 1899, works for the disposal of the sewage of the town of Clinton on lands acquired for the purpose in the town of Lancaster under the authority of chapter 557 of the Acts of the year 1898.

Some interesting experiments have been made during the past year having in view a more satisfactory treatment of the material of which the filter-beds are composed and the results appear to show that improvements and economies of value can be made in the management of such areas.

By section 3 of said chapter "The metropolitan water board shall maintain and operate the works constructed by it, unless otherwise agreed by said board and the town of Clinton, until the sewage of said town shall have outgrown the normal capacity of the south branch of the Nashua river to properly dispose thereof; and then said board shall transfer to said town all the works, lands, water rights, rights of way, easements and other property constructed and acquired under the provisions hereof, upon such terms as may be agreed upon by said board and said town, and thereafter said works, lands, water rights, rights of way, easements and other property shall be owned, maintained and operated by the town of

Clinton under the supervision and control of the state board of health, and said town shall pay to the Commonwealth for the property so transferred such sum or sums, if any, as may be agreed by said town and said board to be just and proper."

In the opinion of the Board the time is near at hand, if it has not already been reached, when this provision of the statute should become operative. Repeated examinations of the material now treated upon the South Lancaster filter-beds both as to quantity and quality would seem to show that the amount of sewage here treated could not be turned into the South Branch of the Nashua River without producing conditions of serious importance to the inhabitants of the towns on the stream below this point.

Two undertakings of the Board have been unusual in character and deserve especial notice: The production of electric power generated by the fall of the water at the Wachusett and Sudbury dams on its way to the aqueducts. This, the first attempt in this country to obviate the waste incident to an unused fall of water, has been so successful that the earnings from this source represent the interest at 4 per cent. upon a million dollars and diminish by this amount the financial burden of the Metropolitan Water District.

The second operation is the reforestation of portions of the large areas surrounding the great reservoirs. These lands were taken for the purpose of protecting the waters in the reservoirs from the pollutions inseparable from the use of this territory for farming.

Tree cultivation appears to be the only safe use of such lands which offers any chance of a profit. For nearly twenty years this policy has been followed and the trees have grown up from inconspicuous seedlings into masses of foliage which have changed the appearance of the whole countryside. More than 2,700,000 trees have been planted and another generation will begin to receive the returns from the judicious use of the tree cuttings that can then be made in successive years.

The details of both of these novel enterprises carried on by a board created for water supply purposes will be found in the annual report of the Chief Engineer of Water Works.

(6) WACHUSETT POWER PLANT.

The hydro-electric power station at the Wachusett Dam was operated on 298 days during the year. The energy not used in connection with the operation of the Metropolitan Water Works was sold to the New England Power Company under an agreement made September 30, 1916, which provides that until the completion of the Wachusett-Sudbury transmission line the Company will take as much energy from the Wachusett power station as it can reasonably and properly use without wasting water at its own plants. For the first time during the seven and one-half years that this plant has been in operation all the water from the reservoir used for water supply purposes has been used to generate electric energy. The operation of the plant continues to be successful, the gross earnings for the year being \$44,145.25. The cost of operating the plant has been \$20,522.49, the net earnings \$23,622.76, and the net earnings per thousand kilowatt hours sold \$2.836.

(7) SUDBURY POWER PLANT.

The hydro-electric power station at the Sudbury Dam was operated on 315 days during the year. The entire output, with the exception of a small amount of energy used for lighting the station and operating the electrically driven accessories, has been sold to the Edison Electric Illuminating Company of Boston under a contract dated December 21, 1914. The gross earnings for the year were \$36,125.39, the cost of operating the plant \$19,713.55 and the net earnings \$16,411.84. The net earnings per thousand kilowatt hours sold were \$2.839.

(8) FORESTRY.

Parcels of water works land located along the margin of the Wachusett Reservoir in Sterling, Boylston and West Boylston, aggregating 90 acres, were planted with three and four-year-old white pines and six-year-old white spruce seedlings from the Oakdale nursery. In the work 91,700 white pines, 43,000 red pines and 1,300 white spruce seedlings were used.

Sixty acres of land bordering on the Wachusett Reservoir and tributary streams, which had been recently burned over or were grown to chestnut trees seriously damaged by the chestnut bark

disease or infested with gypsy moths, were cleared for planting with white pines.

Sprouts and undergrowth, which were interfering with the pines planted during the last few years, were cleared from about 177 acres of land; improvement thinning was made on 14 acres of timber land on the margin of the Wachusett Reservoir; and the thinning begun in 1916 of a portion of Big Crane Swamp in Westborough was continued.

There are now in the Oakdale nursery 364,250 seedlings from one to seven years old. The North Dike nursery has been discontinued and included in the planted area.

Since the beginning of forestal work on Wachusett Reservoir marginal lands 1,521 acres have been planted.

From the Sudbury Reservoir nursery 40,800 three-year-old white pine seedlings were planted east of Acre Bridge, on cleared land on Farm Road; 1,900 four-year-old white pine seedlings at Whitehall Reservoir, and 13,100 four-year-old seedlings at Framingham Reservoir No. 3.

Along the Weston Aqueduct 6,950 four-year-old seedlings, and along the Sudbury and Cochituate aqueducts 11,500 seedlings have been planted during the year.

A small nursery was established on Pond Street at Lake Cochituate and 25,000 two-year-old and 6,550 four-year-old seedlings were set out for future use.

There are now on hand at Sudbury Reservoir nursery 125,000 two-year-old and 10,000 four-year-old white pine seedlings.

The work of attempting to check the spread of the pine-tree weevil and gypsy moth has been continued as far as practicable by spraying and painting egg clusters. The Scotch pine seedlings in the Oakdale nursery have been attacked by the blister rust and the seedlings were destroyed on the advice of the Nursery Inspection Department of the Commonwealth.

(9) RAINFALL AND WATER SUPPLY.

The rainfall is still below the average, and somewhat less than in the preceding year. On the Wachusett watershed the rainfall was 39.77 inches and on the Sudbury watershed 40.54 inches, while the averages for the periods covered by the records have been, respectively, 44.68 inches and 44.51 inches.

The Wachusett watershed yielded a daily average of 902,000 gallons per square mile, which is 85.5 per cent. of the average for the past twenty-two years, and the Sudbury watershed yielded a daily average of 736,000 gallons per square mile, which is 75.49 per cent. of the average for the past forty-four years. The yield from the Cochituate watershed was 758,000 gallons per day per square mile, which is 82.75 per cent. of the average for the past fifty-six years.

(10) WATER CONSUMPTION.

During the year the quantity of water supplied to the Metropolitan Water District amounted to a daily average of 129,764,000 gallons as measured by Metropolitan Water Works meters, which was equivalent to 105 gallons for each person in the District. This quantity was 19,731,700 gallons more than the average daily consumption of the preceding year. This large increase seems to have been partly due to the waste of water to prevent freezing of service pipes.

Acting under authority conferred by several statutes and arrangements which have been made, water has been supplied to a limited extent outside of the Metropolitan Water District. There has been drawn from the open channel of the Wachusett Aqueduct for the use of the Westborough State Hospital a daily average quantity of 163,700 gallons. The town of Framingham has, under the provisions of the statute, drawn indirectly from Farm Pond a daily average quantity of 538,630 gallons and directly from the Sudbury Aqueduct 635,616 gallons. A portion of the town of Saugus has been supplied through the city of Revere with an average of 44,900 gallons daily. The United States Government, for use on Peddock's Island, has been supplied with a daily average of 134,900 gallons. The sums charged for the water thus supplied have amounted to \$11,198.89.

V. WATER WORKS—FINANCIAL STATEMENT.

The financial abstract of the receipts, disbursements, assets and liabilities of the Board for the State fiscal year, beginning with December 1, 1917, and ending with November 30, 1918, was, in accordance with the requirements of chapter 235 of the Acts of the year 1906, presented to the General Court in January last, and a copy of this financial abstract is printed as Appendix No. 5.

As required by said chapter a detailed statement of its doings for the calendar year 1918, in relation to the Metropolitan Water Works, is herewith presented.

CONSTRUCTION.

(1) WATER LOANS — RECEIPTS AND PAYMENTS.

Total loans authorized to January 1, 1919,	\$42,913,000 00
Receipts from the sales of property applicable to the construction and acquisition of works:—	
For the period prior to January 1, 1918,	\$253,845 45
For the year ending December 31, 1918,	3,491 41
	<hr/>
	257,336 86
Receipt from the town of Swampscott for admission to District (St. 1909, c. 320),	90,000 00
	<hr/>
Total amount authorized to January 1, 1919,	\$43,260,336 86
Amounts approved by Board for payments out of Water Loan Fund:—	
Payments prior to January 1, 1918,	\$42,983,832 39
Approved for year ending December 31, 1918,	173,238 26
	<hr/>
	43,157,070 65
	<hr/>
Amount authorized but not expended January 1, 1919,	\$103,266 21

(2) TOTAL WATER DEBT, DECEMBER 31, 1918.

Water Loan Outstanding, Sinking Fund and Debt.

Bonds issued by the Treasurer of the Commonwealth:—

Sinking fund bonds (3 and 3½ per cent.),	\$41,398,000 00
Serial bonds (3½ and 4 per cent.),	1,354,000 00
	<hr/>
Total bond issue to December 31, 1918,	\$42,752,000 00
Serial bonds paid prior to January 1, 1918,	\$104,000 00
Serial bonds paid in 1918,	37,000 00
	<hr/>
	141,000 00
	<hr/>
Total bond issue outstanding December 31, 1918,	\$42,611,000 00
Gross Water Debt,	\$42,611,000 00
Sinking fund December 31, 1918,	14,870,834 84
	<hr/>
Net Water Debt December 31, 1918,	\$27,740,165 16

A decrease for the year of \$871,555.96.

(3) METROPOLITAN WATER LOAN AND SINKING FUND,
DECEMBER 31, 1918.

YEAR.	Authorized Loans.	Bonds issued (Sinking Fund).	Bonds issued (Serial Bonds).	Sinking Fund.
1895	\$27,000,000	\$5,000,000	-	\$226,286 05
1896,	-	2,000,000	-	699,860 70
1897,	-	6,000,000	-	954,469 00
1898,	-	4,000,000	-	1,416,374 29
1899,	-	3,000,000	-	1,349,332 97
1900,	-	1,000,000	-	1,573,619 72
1901,	13,000,000	10,000,000	-	1,662,426 95
1902,	-	3,500,000	-	2,256,803 81
1903,	-	1,500,000	-	2,877,835 59
1904,	-	2,500,000	-	3,519,602 92
1905,	-	650,000	-	4,207,045 69
1906,	500,000	1,350,000	-	4,897,822 62
1907,	-	-	-	5,643,575 69
1908,	398,000	-	-	6,419,283 28
1909,	900,000	398,000	-	7,226,262 31
1910,	80,000	500,000	-	8,089,902 91
1911,	212,000	-	\$200,000	8,953,437 44
1912,	600,000	-	190,000	9,829,356 80
1913,	108,000	-	-	10,767,701 68
1914,	-	-	258,000	11,533,453 45
1915,	-	-	490,000	12,491,245 25
1916,	-	-	66,000	13,268,199 36
1917,	-	-	150,000	14,036,278 88
1918,	115,000	-	-	14,870,834 84
	\$42,913,000	\$41,398,000	\$1,354,000	-

(4) WATER ASSESSMENT, 1918.

The following water assessment was made by the Treasurer of the Commonwealth upon the various municipalities:—

Sinking fund requirements,	\$262,039 38
Serial bonds,	37,000 00
Interest,	1,476,460 54
Maintenance:—	
Appropriated by Legislature,	\$601,500 00
Less balance on hand,	62,702 61
	<hr/>
	538,797 39
Total water assessment for 1918,	<hr/> \$2,314,297 31

In accordance with chapter 488, Acts of 1895, as amended in 1901, 1904 and 1906, the proportion to be paid by each city and town is based one-third in proportion to their respective valuations and the remaining two-thirds in proportion to their respective water consumption for the preceding year, except that but one-fifth of the total valuation and no consumption has been taken for the city of Newton, as it has not been supplied with water from the Metropolitan Works.

The division of the assessment for 1918 was as follows:—

CITIES AND TOWNS.	Assessment.	CITIES AND TOWNS.	Assessment.
Arlington,	\$21,735 89	Nahant,	\$3,848 67
Belmont,	11,402 54	Newton,	5,832 03
Boston,	1,741,008 84	Quincy,	57,975 46
Chelsea,	58,047 20	Revere,	32,414 05
Everett,	57,838 91	Somerville,	125,358 55
Lexington,	9,398 37	Stoneham,	10,009 34
Malden,	49,949 48	Swampscott,	12,351 41
Medford,	36,487 21	Watertown,	31,143 50
Melrose,	20,222 33	Winthrop,	16,843 44
Milton,	12,430 09		<hr/>
			\$2,314,297 31

(5) SUPPLYING WATER TO CITIES AND TOWNS OUTSIDE OF
DISTRICT AND TO WATER COMPANIES.

Sums have been received during the year 1918 under the provisions of the Metropolitan Water Act, for water furnished, as follows: —

Town of Framingham,	\$7,280 58
City of Revere (on account of water furnished to a portion of the town of Saugus for 1917),	270 00
United States Government (for Peddock's Island),	2,495 57
Westborough State Hospital,	2,068 11
	<u>\$12,114 26</u>

The sums so received prior to March 23, 1907, were annually distributed among the cities and towns of the District; but since that date, in accordance with the provisions of chapter 238 of the Acts of 1907, the sums so received have been paid into the sinking fund.

(6) EXPENDITURES FOR THE DIFFERENT WORKS.

The following is a summary of the expenditures made in the various operations for the different works: —

CONSTRUCTION AND ACQUISITION OF WORKS.	For the Year ending December 31, 1918.
Administration applicable to all parts of the construction and acquisition of the works,	\$3,387 26
Wachusett Department, real estate,	32 00
Power Plant at Sudbury Dam,	22 90
Wachusett-Sudbury Power Transmission Line,	62,543 33
Distribution system: —	
Southern high service: —	
Section 47 (additional water supply for Watertown and Belmont),	\$92,221 22
Real estate,	600 00
Northern extra high service: —	
New pumping engine at Arlington pumping station,	19,623 18
Southern extra high service: —	
Section 44 (12-inch connection in West Roxbury),	101 50
Meters and connections,	49 75
	<u>112,595 65</u>
Stock — pipes, valves, castings, etc., purchased and sent first to storage yards, and later transferred, as needed, to the various parts of the work: —	\$178,581 19
Amount received,	\$51,018 34
Transferred from storage yards to the various sections of the work and included in costs of special works,	56,361 27
Deduct excess of transfers over amount purchased during year,	<u>5,342 93</u>
	<u>\$173,238 26</u>
Amount charged from beginning of work to January 1, 1918,	42,983 832 39
Total for construction and acquisition of works to January 1, 1919,	<u>\$43,157,070 65</u>

MAINTENANCE AND OPERATION.	For the Year ending December 31, 1918.	
Administration,		\$15,777 69
General supervision,		33,921 55
Taxes and other expenses,		43,539 54
Wachusett Department: —		
Superintendence,	\$7,359 43	
Reservoir,	4,815 12	
Forestry,	14,860 00	
Protection of supply,	4,321 47	
Buildings and grounds,	4,549 22	
Wachusett Dam,	8,056 22	
Wachusett Aqueduct,	11,517 24	
Clinton sewerage system: —		
Pumping station,	2,091 64	
Sewers, screens and filter-beds,	8,051 43	
Sanitary inspection,	334 81	
Swamp drainage,	3,202 22	
Power plant,	10,379 05	
Wachusett-Sudbury Power Transmission Line,	301 66	
Payments under Industrial Accident Law and special benefit appropriations,	497 05	
		80,366 56
Sudbury Department: —		
Superintendence, Framingham office,	\$10,986 53	
Ashland Reservoir,	3,053 30	
Hopkinton Reservoir,	1,859 11	
Whitehall Reservoir,	1,126 91	
Framingham Reservoirs Nos. 1, 2 and 3,	13,726 87	
Sudbury Reservoir,	10,328 81	
Lake Cochituate,	10,364 70	
Marlborough Brook filters,	2,629 70	
Pegan filters,	5,406 63	
Sudbury and Cochituate watersheds,	2,113 47	
Sanitary inspection,	3,389 21	
Cochituate Aqueduct,	2,894 25	
Sudbury Aqueduct,	10,738 18	
Weston Aqueduct,	9,271 03	
Forestry,	8,219 18	
Power plant,	11,721 68	
Payments under Industrial Accident Law and special benefit appropriations,	480 64	
		108,310 20
Distribution Department: —		
Superintendence,	\$6,061 13	
Pumping service: —		
Superintendence,	4,641 10	
Payments under Industrial Accident Law and special benefit appropriations,	154 50	
Arlington pumping station, pumping service,	13,983 42	
Chestnut Hill low-service pumping station, pumping service,	105,164 64	
Chestnut Hill high-service pumping station, pumping service,	31,308 10	
Spot Pond pumping station, pumping service,	28,536 42	
Hyde Park pumping station, pumping service,	10,602 80	
<i>Amounts carried forward,</i>	\$200,452 11	\$281,915 54

MAINTENANCE AND OPERATION.	For the Year ending December 31, 1918.	
<i>Amounts brought forward,</i>	\$200,452 11	\$281,915 54
Distribution Department — <i>Con.</i>		
Bear Hill Reservoir,	217 94	
Chelsea Reservoir,	194 98	
Chestnut Hill Reservoir and grounds,	11,850 50	
Fells Reservoir,	989 50	
Forbes Hill Reservoir,	1,695 66	
Mystic Lake, conduit and pumping station,	1,902 54	
Mystic Reservoir,	706 46	
Arlington standpipe,	25 00	
Waban Hill Reservoir,	263 67	
Weston Reservoir,	4,052 14	
Spot Pond,	8,224 24	
Buildings at Spot Pond,	2,191 16	
Pipe lines: —		
Low service,	24,142 50	
Northern high service,	7,044 87	
Northern extra high service,	171 67	
Southern high service,	6,885 54	
Southern extra high service,	149 56	
Supply pipe lines,	971 82	
Buildings at Chestnut Hill Reservoir,	5,357 61	
Chestnut Hill pipe yard,	1,588 10	
Glenwood pipe yard and buildings,	2,420 82	
Stables,	8,387 66	
Venturi meters,	1,231 30	
Measurement of water,	2,366 14	
Arlington pumping station, buildings and grounds,	351 52	
Hyde Park pumping station, buildings and grounds,	121 94	
Fisher Hill Reservoir,	3,881 02	
Bellevue Reservoir,	244 19	
Payments under Industrial Accident Law and special benefit appropriations,	751 61	
	298,833 77	
Total for maintaining and operating works,	5580,749 31	

(7) DETAILED FINANCIAL STATEMENT UNDER METROPOLITAN WATER ACT.

The Board herewith presents, in accordance with the requirements of the Metropolitan Water Act, a detailed statement of the expenditures and disbursements, receipts, assets and liabilities for the year 1918.

(a) *Expenditures and Disbursements.*

The total amount of the expenditures and disbursements on account of construction and acquisition of works for the year beginning January 1, 1918, and ending December 31, 1918, was \$173,238.26,

and the total amount from the time of the organization of the Metropolitan Water Board, July 19, 1895, to December 31, 1918, has been \$43,157,070.65.

For maintenance and operation the expenditures for the year were \$580,749.31.

The salaries of the commissioners, and the other expenses of administration, have been apportioned to the construction of the works and to the maintenance and operation of the same, and appear under each of those headings.

The following is a division of the expenditures according to their general character:—

GENERAL CHARACTER OF EXPENDITURES.		For the Year ending December 31, 1918.
CONSTRUCTION OF WORKS AND ACQUISITION BY PURCHASE OR TAKING.		
<i>Administration.</i>		
Commissioners,	\$1,141 67	
Secretary,	550 00	
Clerks and stenographers,	970 53	
Stationery and printing,	268 82	
Postage, express and telegrams,	60 00	
Telephone, lighting, heating, water and care of building,	175 21	
Rent and taxes, main office,	221 03	
		\$3,357 26
<i>Engineering.</i>		
Chief engineer,	\$20 00	
Principal assistant engineers,	1,120 80	
Engineering assistants,	2,585 83	
Consulting engineers,	16 00	
Inspectors,	1,425 00	
Railroad and street car travel,	118 84	
Stationery and printing,	59 37	
Engineering and drafting instruments and tools,	2 75	
Engineering and drafting supplies,	25 70	
Books, maps and photographic supplies,	24 96	
Telephone, lighting, heating, water and care of buildings: —		
Main office,	525 73	
Rent and taxes, main office,	663 10	
Miscellaneous expenses,	126 32	
		6,714 40
<i>Construction.</i>		
Preliminary work: —		
Advertising,		28 43
Contracts, Distribution System: —		
F. C. Alexander, for furnishing and laying granite and seam face masonry for extension of coal pocket at the northern extra high-service pumping station at Arlington, Mass., Contract 390,	\$1,119 00	
<i>Amounts carried forward,</i>		\$1,119 00 \$10,130 09

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1918.	
<i>Amounts brought forward,</i>	\$1,119 00	\$10,130 09
<i>Construction — Con.</i>		
<i>Contracts, Distribution System — Con.</i>		
Builders Iron & Steel Co., for furnishing steelwork for the extension of coal pocket at the northern extra high-service pumping station at Arlington, Mass., Contract 386,	620 00	
New England Iron Works Co., for furnishing 54-inch horizontal fire tube boiler and appurtenances for the northern extra high-service pumping station at Arlington, Mass., Contract 383,	2,324 51	
F. A. Mazzur & Co., for furnishing and installing a centrifugal pumping unit at the northern extra high-service pumping station at Arlington, Mass., Contract 382,	4,880 00	
Michele DeSisto, for laying water pipes on Section 47, southern high service (additional water supply for Watertown and Belmont), Contract 387,	26,630 68	
U. S. Cast Iron Pipe & Foundry Co., for furnishing cast-iron water pipes and special castings, Contract 388,	43,923 15	
U. S. Cast Iron Pipe & Foundry Co., for furnishing flexible jointed pipe and special sleeves, Contract 389,	2,221 37	
<i>Contract, Wachusett-Sudbury Power Transmission Line: —</i>		
Fred T. Ley & Co., Inc., for constructing an electric power transmission line between the Wachusett Power Station in Clinton, Mass., and the Sudbury Power Station in Southborough, Mass., Contract 385,	61,581 00	143,299 71
<i>Additional work: —</i>		
Labor,	\$6,597 42	
Freight and express,	172 24	
Tools, machinery, appliances and hardware supplies,	465 43	
Electrical supplies,	214 72	
Castings, ironwork and metals,	1,023 77	
Iron pipe and valves,	4,856 37	
Paint and coating,	463 75	
Lumber and field buildings,	594 57	
Brick, cement and stone,	1,146 28	
Sand, gravel and filling,	49 95	
Municipal and corporation work,	3,147 23	
Unclassified supplies,	34 96	
Miscellaneous expenses,	254 29	
		19,020 98
<i>Real Estate.</i>		
<i>Legal and expert: —</i>		
Conveyancing expenses,	\$105 48	
Miscellaneous expenses,	50 00	
Settlements made by the Board,	632 00	
		787 48
Amount charged from beginning of work to January 1, 1918,		\$173,238 26
		42,983,832 39
Total amount of construction expenditures to January 1, 1919,		\$43,157,070 65

GENERAL CHARACTER OF EXPENDITURES.		For the Year ending December 31, 1918.
MAINTENANCE AND OPERATION OF WORKS.		
Administration: —		
Commissioners,	\$6,208 33	
Secretary and assistants,	6,479 54	
Rent,	574 57	
Repairs of building,	4 20	
Fuel,	86 78	
Lighting,	52 74	
Care of building,	561 32	
Postage,	165 00	
Printing, stationery and office supplies,	1,189 94	
Telephones,	124 17	
Traveling expenses,	134 75	
Miscellaneous expenses,	196 35	
		\$15,777 69
General supervision: —		
Chief engineer and assistants,	\$26,594 55	
Rent,	1,723 70	
Repairs of building,	197 56	
Fuel,	260 34	
Lighting,	163 15	
Care of building,	1,684 35	
Postage,	122 00	
Express and telegrams,	132 69	
Printing, stationery and office supplies,	614 25	
Telephones,	435 55	
Traveling expenses,	1,323 05	
Miscellaneous expenses,	670 36	
		33,921 55
Pumping service: —		
Superintendence,	\$4,641 10	
Labor,	86,050 34	
Fuel,	93,428 59	
Oil, waste and packing,	2,088 82	
Repairs,	6,272 44	
Small supplies,	1,755 19	
Payments under Industrial Accident Law and special benefit appropriations,	154 50	
		194,390 98
Reservoirs, aqueducts, pipe lines, buildings and grounds: —		
Superintendents,	\$7,320 00	
Engineering assistants,	12,334 01	
Sanitary inspectors,	3,096 76	
Labor, pay roll,	208,963 58	
Labor, miscellaneous,	3,983 03	
Alterations and repairs of pumping stations,	1,861 73	
Amounts carried forward,	\$237,559 11	\$244,090 22

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1918.	
<i>Amounts brought forward,</i>	\$237,559 11	\$244,090 22
Reservoirs, aqueducts, pipe lines, buildings and grounds — <i>Con.</i>		
Alterations and repairs of other buildings and structures,	2,476 65	
Automobiles,	7,755 35	
Brick,	192 10	
Brooms, brushes and janitor's supplies,	353 04	
Castings, ironwork and metals,	1,123 03	
Cement and lime,	470 49	
Drafting and photo supplies,	217 36	
Electrical supplies,	3,590 57	
Fertilizer and planting material,	318 72	
Freight and express,	691 06	
Fuel,	3,714 54	
Gypsy moth supplies,	3,962 34	
Hardware,	2,240 34	
Hay and grain,	1,199 90	
Lighting,	300 34	
Lumber,	1,902 71	
Machinery,	1,914 09	
Paints and oils,	1,829 39	
Pipe and fittings,	913 59	
Postage,	171 02	
Printing, stationery and office supplies,	826 41	
Rubber and oiled goods,	256 90	
Stable expenses,	1,052 81	
Sand, gravel and stone,	340 37	
Traveling expenses,	2,857 90	
Telephones,	1,694 89	
Teaming,	3,753 68	
Tools and appliances,	2,437 09	
Vehicles, harnesses and fittings,	162 61	
Miscellaneous expenses,	3,766 85	
Contracts: —		
The Pelton Water Wheel Co., Contract 60-M, for furnishing one 18-inch Pelton motor and one 2½ kilowatt 110-volt direct current generator for electric lights at Spot Pond Pumping Station and foreman's house,	545 00	
Union Gear & Machine Co., Contract 61-M, for making and delivering head gate hoists for Wachusett Aqueduct,	800 00	
Payments under Industrial Accident Law and special benefit appropriations,	1,729 30	
Payments in lieu of taxes,		293,119 55
Total expenditures for maintenance and operation,		43,539 54
		\$580,749 31

(b) *Receipts.*

The total amount of receipts from the operations of the Board and from sales of property for the year beginning January 1, 1918, and ending December 31, 1918, was \$105,686.83, and the total amount

from the time of the organization of the Metropolitan Water Board, July 19, 1895, to December 31, 1918, has been \$1,498,377.70. The general character of these receipts is as follows: —

GENERAL CHARACTER OF RECEIPTS.	For the Year ending December 31, 1918.
Applicable to the loan fund: —	
Construction tools, supplies and reimbursements,	\$3,491 41
Applicable to payment of interest, sinking fund requirements and expenses of maintenance and operation: —	
Proceeds from operations of the Board: —	
Rents,	\$1,868 00
Land products,	5,585 18
Electric energy,	78,376 23
Maintenance labor, tools, supplies and reimbursements,	4,154 55
Interest and unclassified receipts,	97 20
	90,081 16
Applicable to the sinking fund: —	
Water supplied to cities and towns, water companies and others,	12,114 26
	\$105,686 83
Amount credited from beginning of work to January 1, 1918,	1,392,690 87
Total receipts to January 1, 1919,	\$1,498,377 70

The foregoing receipts have been credited to the various objects or works, as follows: —

SOURCES OF RECEIPTS.	For the Year ending December 31, 1918.
Supplying water outside of Water District,	\$12,114 26
Construction and acquisition of works: —	
Administration,	\$41 02
Distribution system,	3,490 91
	3,531 93
Maintenance and operation of works: —	
Administration,	\$248 11
General supervision,	531 22
Wachusett Aqueduct,	622 62
Wachusett Reservoir,	4,231 41
Wachusett electric power plant,	42,418 00
Sudbury system,	2,921 71
Sudbury electric power plant,	35,958 23
Distribution system,	2,375 03
Clinton sewerage system,	734 31
	90,040 64
	\$105,686 83
Amount credited from beginning of work to January 1, 1918,	1,392,690 87
Total receipts to January 1, 1919,	\$1,498,377 70

(c) *Assets.*

The following is an abstract of the assets of the Water Works, a complete schedule of which is kept on file in the office of the Board: —

Office furniture, fixtures and supplies; engineering and scientific instruments and supplies; police supplies; horses, vehicles, field machinery, etc.; machinery, tools and other appliances and supplies; completed works, real estate and buildings connected therewith.

(d) *Liabilities.*

The sums due on monthly pay rolls amount to \$411.94 and there are bills for current expenses which have not yet been received.

Amounts on Monthly Estimates, not due until Completion of Contracts or until Claims are settled.

NAME.	Work.	Amount.
Joseph Hanreddy,	Contract 314, Section 7 of the Weston Aqueduct Supply Mains, in Newton, Mass.	\$10 00
F. A. Mazzur & Co.,	Contract 382, for furnishing and installing a centrifugal pumping unit at the northern extra high-service pumping station at Arlington, Mass.	970 00
Michele DeSisto,	Contract 387, Section 47 of southern high-service pipe line (additional water supply for Watertown and Belmont).	4,699 53
U. S. Cast Iron Pipe and Foundry Co.,	Contract 388, for cast-iron pipe and special castings for the Distribution System.	7,751 15

Settlements are pending with the following parties for land and easements taken in lands owned by them: —

D. Blakeley Hoar and George R. Nutter, New York, New Haven & Hartford Railroad Company, Frederique Ropp.

VI. METROPOLITAN SEWERAGE WORKS.

The North Metropolitan Sewerage District embraces the cities of Cambridge, Chelsea, Everett, Malden, Medford, Melrose, Revere, Somerville and Woburn, and the towns of Arlington, Belmont, Reading, Stoneham, Wakefield, Winchester and Winthrop and parts of the city of Boston and the town of Lexington, — comprising in all 10 cities and 8 towns, with an area of 100.32 square miles. The district has an estimated population, based upon the census of 1915, as of December 31, 1918, of 646,270. Of the total population it is

estimated that 89.7 per cent., or 579,440 people, contribute sewage to the North Metropolitan System.

The South Metropolitan Sewerage District includes the cities of Newton, Quincy and Waltham, and the towns of Brookline, Milton, Watertown and Wellesley, and parts of the city of Boston and the town of Dedham, — a total of 4 cities and 5 towns. This district has an area of 110.76 square miles, with an estimated population as of December 31, 1918, of 491,200. According to the estimates made 75.9 per cent. of this population, or 372,980, contribute sewage to the South Metropolitan System.

(1) NORTH METROPOLITAN SEWERAGE SYSTEM — CONSTRUCTION.

The amount expended for construction on account of the North Metropolitan System during the past year was \$35,738.27.

The extension of the Deer Island outfall, authorized by chapter 344 of the Acts of 1914, has been completed and for the past year the sewage of the district has been discharged through the new openings. A carefully contrived distribution of the effluent matters over a considerable area at a distance below the surface of the harbor offers the best obtainable solution of the nuisance hitherto existing. Observation at this season of the year has shown the method to be successful.

By chapter 159 of the Acts of 1916 the town of Reading became a part of the North Metropolitan Sewerage District and has thus far complied with all the terms of payment provided by the statute. The plans for the construction of the necessary connecting sewer have been made, but no contractor has been found who is willing to undertake its construction within the limits of the appropriation made for this purpose. The Board, however, found that a profitable use could be made of the plant of Bruno & Petitti, who were about completing certain sewer work for the town of Reading and had on hand all the apparatus necessary for sewer construction and, believing that it was not probable in the near future that any contractors could more economically perform the work upon a limited portion of the projected sewer than these competent contractors, made a contract with them for the construction of 1,370 feet of sewer in open cut in direct continuation of the sewer already constructed in the town of Reading. This work has been successfully prosecuted and will probably be finished in the coming spring.

The Board has had under consideration some modification of the plan adopted by the joint commission in July, 1914, in the hope that a satisfactory disposal of the sewage of the town of Reading may be obtained for a dozen years at least at a reasonable cost.

The Board acquired by taking during the year easements in 1,299 acres of land in Reading, Stoneham and Wakefield for the construction of the Reading extension of the North Metropolitan Sewerage System.

(2) NORTH METROPOLITAN SEWERAGE SYSTEM — MAINTENANCE.

The cost of the maintenance and operation of the North Metropolitan System during the past year was \$230,021.71.

Sewers and Pumping Stations.

The metropolitan sewers in the North Metropolitan System now extend a distance of 64.028 miles, and the local sewers which are connected with the metropolitan sewers have a further length of 774.30 miles, involving 84,773 connections.

The sewage of the North Metropolitan District flows at first by gravity, but before being finally disposed of is lifted at different points by pumping and is finally discharged into the harbor from an outfall off Deer Island.

The daily average amount of sewage discharged into the harbor was 66,500,000 gallons, a daily average for each person contributing sewage of 115 gallons. The increase in the total amount of sewage discharged was 1,900,000 gallons per day more than the discharge of the preceding year. The maximum rate of discharge in any one day was 163,000,000 gallons.

The pumping stations operated for the North Metropolitan Sewerage System are as follows: —

	Number of Engines.	Contract Capacity per Day (Gallons).	Lift (Feet).
Deer Island station (Boston Harbor),	4	235,000,000	19
East Boston station,	4	235,000,000	19
Charlestown station,	3	104,000,000	{ 11 8
Alewife Brook station (Somerville),	3	22,000,000	

There were purchased for the operation of the pumping stations 7,020 tons of bituminous coal and 40 tons of anthracite screenings, the average prices of which, at the different stations, varied from \$10.74 to \$11.31 per gross ton for the bituminous coal and from \$5.30 to \$7.11 for the screenings, delivered in the bins.

The amount expended for the stations was \$162,012.39. The average cost per million gallons of sewage lifted per foot at the several stations was \$0.214, an increase of 35 per cent. over the cost last year.

(3) SOUTH METROPOLITAN SEWERAGE SYSTEM — CONSTRUCTION.

The amount expended for construction on account of the South Metropolitan System during the past year was \$115,596.89.

The town of Wellesley was admitted to the South Metropolitan Sewerage District by chapter 343 of the Acts of 1914, and the act was accepted by the town in March, 1915.

The original estimate for the construction of the Wellesley extension, High-level sewer, of \$350,000, was made by the State Board of Health, and was based on a report submitted by an engineer called in by that department to make a survey and estimate. Two lines were considered by the Board of Health. The estimate was made on the shorter line which came through the location of the Brookline Water Works fields. This line was to connect with the existing Neponset Valley sewer of the High-level System at a point where the sewer has a capacity suitable only for the original district for which it was built.

Because of the small size of this existing Metropolitan sewer and the fact that this line extended across the Brookline Water Works fields and would interfere with this important supply, and also because of the fact that there is a rapidly growing portion of Dedham in the vicinity of Bridge Street which is a part of the Metropolitan District and has no possible means of reaching the Metropolitan System excepting by construction work by the Metropolitan Water and Sewerage Board, it was decided to use the alternate line proposed by the State Board of Health.

The line adopted has a length of about 40,000 feet almost wholly through private lands. The natural physical conditions in this part of the Charles River valley make sewer construction very expensive. This is occasioned by the large amount of rock encountered and by

fine sands and other material in which it is expensive to construct and by the remoteness of the location.

Because of the above-stated conditions, namely, insufficiency of the original appropriation, not based on estimates made by the Metropolitan Water and Sewerage Board, and the necessary changes in the location to fit the needs of the District, the bad material encountered and, above all, the abnormal conditions of the market in regard to labor and supplies, an additional appropriation of \$325,000 was made by the Legislature of 1917. It is not probable that the remainder of this work, consisting of nearly three sections of the nine into which the whole line was divided, can be completed within the appropriation. The contractor for one of the sections undertaken in the year 1917 found difficulties in carrying out his contract so serious that he felt obliged to abandon the work before any permanent construction of the sewer had been effected. The Board then took over the work under the oversight of a sewer builder of much experience and the undertaking has been successfully carried on under great difficulties and is now substantially completed, but at a very large increase in expense over the contract price.

Borings along the line of the proposed sewer were made in the usual manner and samples of the materials found in the borings were exhibited to those who proposed to bid for the work, but even experienced contractors misjudged the probable behavior of these materials and the cost of the work has far outrun the estimates.

An appropriation of \$225,000 has been asked for the completion of this sewer of which more than two-thirds has been finished, but even now the Board makes any estimate of probable cost with much hesitation.

(4) SOUTH METROPOLITAN SEWERAGE SYSTEM—MAINTENANCE.

The entire cost of maintenance of the South Metropolitan System during the past year was \$155,874.58.

Sewers and Pumping Stations.

The metropolitan sewers in the South Metropolitan System, which comprise the old Charles River valley sewer and Neponset River valley sewer, as well as the new High-level sewer and extensions, have a total length of 49.212 miles, and with these are connected

local sewers having a length of 658.10 miles, involving 45,598 connections.

The pumping stations operated for the South Metropolitan Sewerage system are as follows:—

	Number of Engines.	Contract Capacity per Day (Gallons).	Lift (Feet).
Ward Street station (Roxbury District),	2	100,000,000	45
Quincy station,	3	18,000,000	28
Quincy sewerage lifting station,	2	3,000,000	20

The sewage of two small areas in Dorchester and Milton, included in the Neponset River valley system, which are too low for sewage to be delivered into the High-level sewer by gravity, is, under an arrangement with the city of Boston, disposed of through the Boston Main Drainage Works at Moon Island. By this arrangement the Board is relieved from the expense of providing extra pumping facilities.

A large part of the sewage of the South District is lifted into the High-level sewer at the Ward Street pumping station in Roxbury. Most of the sewage of the city of Quincy is pumped into the High-level sewer at Greenleaf Street near the Quincy pumping station. All of the sewage of the South District is screened at the Nut Island screen-house for the purpose of intercepting solid matter, and is thence discharged at the bottom of the harbor from the outfalls about a mile off the island.

The daily average amount of sewage thus discharged was 56,200,000 gallons, and the largest rate of discharge in a single day was during a heavy storm, when the amount reached 152,500,000 gallons. The decrease in the daily average from last year was 4,000,000 gallons. The daily average discharge of sewage for each individual contributing sewage in the district was 151 gallons.

There were 3,908 gross tons of bituminous coal and 15 tons of anthracite screenings purchased at the two pumping stations and the Nut Island screen-house, the average prices of which varied from \$9.54 to \$11.51 per gross ton for the bituminous coal delivered in the bins. The screenings were purchased for \$7.74 per ton.

The total amount expended for the operation of the stations was \$102,822.28.

VII. SEWERAGE WORKS—FINANCIAL STATEMENT.

The financial abstract of the receipts, expenditures, disbursements, assets and liabilities of the Metropolitan Water and Sewerage Board for the fiscal year of the Commonwealth ending with November 30, 1918, was, as stated in connection with the Water Works, presented to the General Court in January, in accordance with the requirements of chapter 235 of the Acts of the year 1906, and a copy of this financial abstract is in part printed as Appendix No. 5.

The following statement of its financial doings, in relation to the Metropolitan Sewerage Works, for the calendar year 1918 is herewith presented, in accordance with the provisions of the act of 1906, as a part of the annual report of the Board.

(1) METROPOLITAN SEWERAGE LOANS, RECEIPTS AND PAYMENTS.

The loans authorized for the construction of the Metropolitan Sewerage Works, the receipts which are added to the proceeds of these loans, the expenditures for construction, and the balances available on January 1, 1919, have been as follows:—

North Metropolitan System.

Loans authorized under various acts to January 1, 1919, for the construction of the North Metropolitan System and the various extensions,	\$7,512,365 73
Receipts from sales of real estate and from miscellaneous sources which are placed to the credit of the North Metropolitan System:—	
For the year ending December 31, 1918,	\$31 70
For the period prior to January 1, 1918,	85,989 49
	<hr/>
	86,021 19
	<hr/>
	\$7,598,386 92
Amount approved for payment by the Board ¹ out of the Metropolitan Sewerage Loan Fund, North System:—	
For the year ending December 31, 1918,	\$35,738 27
For the period prior to January 1, 1918,	7,293,288 27
	<hr/>
	7,329,026 54
	<hr/>
Balance, North Metropolitan System, January 1, 1919,	\$269,360 38

¹ The word "Board" refers to the Metropolitan Sewerage Commission and the Metropolitan Water and Sewerage Board.

South Metropolitan System.

Loans authorized under the various acts to January 1, 1919,
 applied to the construction of the Charles River valley
 sewer, Neponset valley sewer, High-level sewer and exten-
 sions, constituting the South Metropolitan System, . . . \$9,587,046 27

Receipts from pumping, sales of real estate and from miscella-
 neous sources, which are placed to the credit of the South
 Metropolitan System: —

For the year ending December 31, 1918, . . .	\$30 70	
For the period prior to January 1, 1918, . . .	19,384 33	
	<hr/>	19,415 03
		<hr/>
		\$9,606,461 30

Amount approved by the Board for payment out of the Met-
 ropolitan Sewerage Loan Fund, South System: —

On account of the Charles River valley sewer, . .	\$800,046 27
On account of the Neponset valley sewer, . . .	911,531 46
On account of the High-level sewer and exten- sions, including Wellesley extension: —	

For the year ending December

31, 1918,	\$115,596 89
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For the period prior to January

1, 1918,	7,652,149 90
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	<hr/>	7,767,746 79
		<hr/>
		9,479,324 52

Balance, South Metropolitan System, January 1, 1919, . .	\$127,136 78
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(2) TOTAL SEWERAGE DEBT, DECEMBER 31, 1918.

North Metropolitan System.

Bonds issued by the Treasurer of the Commonwealth:—

Sinking fund bonds (3 and 3½ per cent.),	\$6,563,000 00
Serial bonds (3½ and 4 per cent.),	925,500 00

Total bond issue to December 31, 1918,	\$7,488,500 00
Serial bonds paid prior to January 1, 1918,	\$75,000 00
Serial bonds paid in 1918,	26,500 00
	<hr/> 101,500 00

Total bond issue outstanding December 31, 1918, \$7,387,000 00

Gross Sewerage Debt,	\$7,387,000 00
Sinking fund December 31, 1918,	2,690,491 90

Net Sewerage Debt December 31, 1918, \$4,696,508 10

A net decrease for the year of \$241,826.02.

South Metropolitan System.

Bonds issued by the Treasurer of the Commonwealth:—

Sinking fund bonds (3 and 3½ per cent.),	\$8,877,912 00
Serial bonds (4 and 5 per cent.),	720,000 00

Total bond issue to December 31, 1918,	\$9,597,912 00
Serial bonds paid prior to January 1, 1918,	\$21,000 00
Serial bonds paid in 1918,	21,000 00
	<hr/> 42,000 00

Total bond issue outstanding December 31, 1918, \$9,555,912 00

Gross Sewerage Debt,	\$9,555,912 00
Sinking fund December 31, 1918,	1,579,713 60

Net Sewerage Debt December 31, 1918, \$7,976,198 40

An increase for the year of \$174,913.27.

(3) NORTH AND SOUTH METROPOLITAN LOAN AND SINKING FUNDS,
DECEMBER 31, 1918.

YEAR.	LOANS.		BONDS ISSUED (SINKING FUND).		BONDS ISSUED (SERIAL BONDS).		SINKING FUND.
	North System.	South System.	North System.	South System.	North System.	South System.	North and South Systems.
1889, . .	\$5,000,000 00	-	-	-	-	-	-
1890, . .	-	-	\$2,200,000	\$800,000	-	-	-
1891, . .	-	-	368,000	-	-	-	-
1892, . .	-	-	1,053,000	-	-	-	-
1893, . .	-	-	579,000	-	-	-	-
1894, . .	500,000 00	-	500,000	-	-	-	-
1895, . .	300,000 00	\$500,000 00	300,000	300,000	-	-	-
1896, . .	30,000 00	-	30,000	200,000	-	-	-
1897, . .	85,000 00	300,000 00	80,000	300,000	-	-	-
1898, . .	215,000 00	35,000 00	220,000	35,000	-	-	-
1899, . .	-	4,625,000 00	-	1,025,000	-	-	\$361,416 59
1900, . .	265,000 00	10,912 00	265,000	10,912	-	-	454,520 57
1901, . .	-	40,000 00	-	2,040,000	-	-	545,668 26
1902, . .	-	-	-	864,000	-	-	636,084 04
1903, . .	500,000 00	1,000,000 00	500,000	1,736,000	-	-	754,690 41
1904, . .	-	392,000 00	-	392,000	-	-	878,557 12
1905, . .	-	-	-	-	-	-	1,008,724 95
1906, . .	55,000 00	1,175,000 00	55,000	175,000	-	-	1,146,998 68
1907, . .	-	-	-	300,000	-	-	1,306,850 30
1908, . .	413,000 00	-	-	700,000	-	-	1,492,418 98
1909, . .	-	-	300,000	-	-	-	1,673,784 40
1910, . .	56,000 00	-	113,000	-	-	-	1,931,741 89
1911, . .	6,000 00	-	-	-	-	-	2,184,674 98
1912, . .	378,000 00	-	-	-	\$62,000	-	2,458,541 20
1913, . .	-	-	-	-	378,000	-	2,749,337 90
1914, . .	130,500 00	350,000 00	-	-	-	-	3,011,512 44
1915, . .	83,000 00	5,000 00	-	-	130,500	-	3,290,979 46
1916, . .	285,000 00	40,000 00	-	-	70,000	\$355,000	3,604,657 27
1917, . .	-	325,000 00	-	-	285,000	40,000	3,925,792 75
1918, . .	-	-	-	-	-	325,000	4,270,205 50
	\$8,301,500 00 ²	\$8,797,912 00	-	-	-	-	-
	789,134 27	789,134 27	-	-	-	-	-
	\$7,512,365 73	\$9,587,046 27	\$6,563,000	\$8,877,912	\$925,500	\$720,000	-

¹ The sum of \$10,912 was appropriated to reimburse the town of Watertown for the expense of constructing the Watertown siphon.

² Of this amount, \$789,134.27 was expended for the construction of the Charles River valley sewer, which is now included in the South Metropolitan System.

(4) ANNUAL APPROPRIATIONS, RECEIPTS AND EXPENDITURES.

The annual appropriations for the maintenance of the Metropolitan Sewerage Works, the receipts of the Board which are added to the appropriations for maintenance, and the expenditures for maintenance for the year ending December 31, 1918, were as follows:—

North Metropolitan System.

Appropriation as follows:—

Chapter 67, Special Acts of 1918,	\$235,700 00
Receipts from pumping and from other sources,	807 68
	<hr/>
	\$236,507 68
Amount approved by the Board for payment,	230,021 71
	<hr/>
Balance January 1, 1919,	\$6,485 97

South Metropolitan System.

Appropriation as follows:—

Chapter 67, Special Acts of 1918,	\$145,860 00
Receipts from pumping and from other sources,	10,763 65
	<hr/>
	\$156,623 65
Amount approved by the Board for payment,	155,874 58
	<hr/>
Balance January 1, 1919,	\$749 07

(5) SEWER ASSESSMENTS, 1918.

The following sewer assessments were made by the Treasurer of the Commonwealth upon the various municipalities:—

North Metropolitan Sewerage System.

Sinking fund requirements,	\$119,725 49
Serial bonds,	24,000 00
Interest,	231,648 74
Maintenance:—	
Appropriated by Legislature,	\$235,700 00
Less balance on hand,	14,946 02
	<hr/>
	220,753 98
	<hr/>
Total North Metropolitan sewerage assessment,	\$596,128 21

South Metropolitan Sewerage System.

Sinking fund requirements,	\$74,272 86
Serial bonds,	20,902 50
Interest,	327,436 21
Maintenance:—	
Appropriated by Legislature,	\$145,860 00
Less balance on hand,	2,895 70
	<hr/> 142,964 30
Total South Metropolitan sewerage assessment,	\$565,575 87

In accordance with the provisions of chapter 369, Acts of 1906, the proportion to be paid by each city and town to meet the interest and sinking fund requirements for each year is based upon their respective taxable valuations, and to meet the cost of maintenance and operation upon their respective populations.

The divisions of the assessments for 1918 were as follows:—

North Metropolitan Sewerage System.

CITIES AND TOWNS.	Assessment.	CITIES AND TOWNS.	Assessment.
Arlington,	\$17,349 75	Reading, ¹	\$5,217 70
Belmont,	11,132 41	Revere,	23,540 26
Boston,	93,045 57	Somerville,	80,430 29
Cambridge,	127,065 18	Stoneham,	6,594 86
Chelsea,	35,579 26	Wakefield,	12,673 22
Everett,	34,676 69	Winchester,	15,802 33
Lexington,	5,946 00	Winthrop,	15,091 08
Malden,	46,453 57	Woburn,	15,558 85
Medford,	31,120 13	Total,	<hr/> \$596,128 21
Melrose,	18,851 06		

¹ Reading is also assessed \$7,000 for sinking fund requirements in accordance with section 5, chapter 159, General Acts of 1916.

South Metropolitan Sewerage System.

CITIES AND TOWNS.	Assessment.	CITIES AND TOWNS.	Assessment.
Boston,	\$257,203 09	Quincy,	\$38,848 28
Brookline,	106,668 97	Waltham,	28,595 64
Dedham,	12,931 89	Watertown,	18,355 28
Milton,	23,456 65	Wellesley, ¹	11,833 12
Newton,	67,682 95	Total,	<hr/> \$565,575 87

¹ Wellesley is also assessed \$6,775.23 for sinking fund requirements in accordance with section 5, chapter 343, Acts of 1914.

(6) EXPENDITURES FOR THE DIFFERENT WORKS.

The following is a summary of the expenditures made in the various operations for the different works: —

CONSTRUCTION AND ACQUISITION OF WORKS.		For the Year ending December 31, 1918.
NORTH METROPOLITAN SYSTEM.		
North System, enlargement: —		
Administration,		\$2,606 01
Deer Island Outfall extension,		7,437 56
Removal of old Malden River siphon,		113 34
Reading extension,		25,581 36
		<hr/> \$35,738 27
Amount charged from beginning of work to January 1, 1918,		7,293,288 27
		<hr/>
Total for North Metropolitan System to January 1, 1919,		\$7,329,026 54
SOUTH METROPOLITAN SYSTEM.		
High-level sewer extensions: —		
Administration,		\$3,546 57
Wellesley extension: —		
Section 98,	\$75,014 94	
Section 99,	14,104 98	
Section 100,	408 93	
Section 101,	29 95	
Section 102,	14,025 41	
Section 103,	346 00	
Section 104,	315 53	
Section 105,	506 45	
Section 106,	943 80	
Real estate settlements,	4,330 00	
Legal, conveyancing and expert,	1,656 50	
Payments under Industrial Accident Law and special benefit appropriations,	96 00	
		<hr/> 111,778 49
Additions to Ward Street pumping station plant,		271 83
		<hr/> \$115,596 89
Amount charged from beginning of work to January 1, 1918,		9,363,727 63
		<hr/>
Total for South Metropolitan System to January 1, 1919,		\$9,479,324 52
		<hr/>
Total for construction, both systems,		\$16,808,351 06

MAINTENANCE AND OPERATION.		For the Year ending December 31, 1918.
North Metropolitan System,		
		\$230,021 71
South Metropolitan System,		
		155,874 58
		<hr/>
Total for maintenance, both systems,		\$385,896 29

(7) DETAILED FINANCIAL STATEMENT.

The Board herewith presents, in accordance with the Metropolitan Sewerage acts, an abstract of the expenditures and disbursements, receipts, assets and liabilities for the year ending December 31, 1918:—

(a) *Expenditures and Disbursements.*

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1918.
CONSTRUCTION OF WORKS AND ACQUISITION BY PURCHASE OR TAKING. <i>North System Enlargement.</i>	
Administration:—	
Commissioners,	\$1,000 00
Secretary,	300 00
Clerks and stenographers,	795 53
Stationery, printing and office supplies,	253 96
Telephone, lighting, heating, water and care of building,	137 37
Rent and taxes, main office,	107 10
Miscellaneous expenses,	12 00
	<hr/> \$2,606 01
Engineering:—	
Chief engineer,	\$625 01
Engineering assistants,	3,798 16
Inspectors,	75 00
Traveling expenses,	19 40
Stationery, printing and office supplies,	1 97
Telephone, lighting, heating, water and care of building,	412 29
Rent and taxes,	321 30
Miscellaneous expenses,	159 78
	<hr/> 5,412 91
Brick, cement, lumber and other field supplies and expenses,	<hr/> \$151 26
	<hr/> 151 26
Contracts:—	
Bruno & Petitti, Contract 144, for constructing a part of Section 76 of the Reading Extension of the North Metropolitan System,	<hr/> \$20,979 84
Roy H. Beattie Inc., Contract 135, for constructing Section 1 of the Deer Island Outfall sewer extension in Boston Harbor,	6,581 09
	<hr/> 27,560 93
Real estate:—	
Legal, conveyancing and expert,	<hr/> \$7 16
	<hr/> 7 16
Total for North Metropolitan System,	<hr/> \$35,738 27

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1918.
SOUTH METROPOLITAN SYSTEM. <i>High-level Sewer Extensions.</i>	
Administration: —	
Commissioners,	\$1,333 33
Secretary,	450 00
Clerks and stenographers,	1,173 25
Stationery, printing and office supplies,	268 36
Telephone, lighting, heating, water and care of building,	156 61
Repairs of building,	4 26
Rent and taxes, main office,	152 96
Miscellaneous expenses,	7 80
	<hr/> \$3,546 57
Engineering: —	
Chief engineer,	\$1,041 67
Engineering assistants,	5,676 52
Inspectors,	2,978 18
Traveling expenses,	129 13
Engineering and drafting instruments and tools,	34 92
Stationery, printing and office supplies,	28 25
Engineering and drafting supplies,	17 65
Telephone, lighting, heating, water and care of building,	469 95
Repairs of building,	12 79
Rent and taxes, main office,	459 00
Miscellaneous expenses,	458 82
	<hr/> 11,306 88
Labor and teaming,	\$1,414 72
Tools, machinery and appliances,	273 24
Brick, cement, lumber and other field supplies and expenses,	2,425 67
	<hr/> 4,113 63
Contracts: —	
Bruno & Petitti, Contract 143, for constructing Section 102 of the High-level sewer (Wellesley extension) in Needham,	<hr/> \$11,784 73
George M. Byrne, under agreement dated October 23, 1916, for constructing Section 98 of the High-level sewer (Wellesley extension) in West Roxbury and Dedham,	<hr/> 68,089 15
George M. Bryne, under agreement dated October 6, 1917, for constructing Section 99 (in part) of the High-level sewer (Wellesley extension) in Dedham,	<hr/> 14 43
Rowe Contracting Co., Contract 139, for constructing Section 99 (in part) of the High-level sewer (Wellesley extension) in Dedham,	<hr/> 10,659 00
	<hr/> 90,547 31
Payments under Industrial Accident Law and special benefit appropriations,	<hr/> \$96 00
	<hr/> 96 00
Real estate: —	
Legal, conveyancing and expert,	\$1,656 50
Settlements,	4,330 00
	<hr/> 5,986 50
Total for South Metropolitan System,	<hr/> \$115,596 89

GENERAL CHARACTER OF EXPENDITURES.		For the Year ending December 31, 1918.
MAINTENANCE AND OPERATION OF WORKS, <i>North Metropolitan System.</i>		
Administration: —		
Commissioners,	\$2,333 34	
Secretary and assistants,	2,841 16	
Rent,	275 40	
Heating, lighting and care of building,	395 55	
Repairs of building,	2 44	
Postage,	60 00	
Printing, stationery and office supplies,	493 37	
Telephones,	45 92	
Miscellaneous expenses,	35 20	
		\$6,482 38
General supervision: —		
Chief engineer and assistants,	\$7,145 06	
Rent,	826 20	
Heating, lighting and care of building,	1,187 02	
Repairs of building,	7 31	
Printing, stationery and office supplies,	381 65	
Telephones,	137 78	
Traveling expenses,	75 00	
Miscellaneous expenses,	27 97	
		9,767 99
Deer Island pumping station: —		
Labor,	\$22,383 93	
Fuel,	28,671 90	
Oil and waste,	153 41	
Water,	1,341 60	
Packing,	126 89	
Repairs and renewals,	801 29	
Telephones,	32 95	
General supplies,	739 47	
Miscellaneous supplies and expenses,	480 66	
		54,737 10
East Boston pumping station: —		
Labor,	\$24,096 64	
Fuel,	31,619 00	
Oil and waste,	712 71	
Water,	1,786 08	
Packing,	192 23	
Repairs and renewals,	1,747 84	
Telephones,	4 05	
General supplies,	612 84	
Miscellaneous supplies and expenses,	513 16	
		61,284 55
Charlestown pumping station: —		
Labor,	\$18,644 57	
Fuel,	10,444 21	
Oil and waste,	309 84	
Amounts carried forward,	\$29,398 62	\$132,292 02

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1918.	
<i>Amounts brought forward,</i>	\$29,398 62	\$132,292 02
<i>North Metropolitan System — Con.</i>		
Charlestown pumping station — <i>Con.</i>		
Water,	643 20	
Packing,	78 89	
Repairs and renewals,	315 57	
Telephones,	51 53	
General supplies,	360 88	
Miscellaneous supplies and expenses,	195 90	
		31,044 59
Alewife Brook pumping station: —		
Labor,	\$9,195 76	
Fuel,	4,718 57	
Oil and waste,	239 94	
Water,	229 44	
Packing,	32 72	
Repairs and renewals,	250 96	
Telephones,	40 00	
General supplies,	192 75	
Miscellaneous supplies and expenses,	46 01	
		14,946 15
Sewer lines, buildings and grounds: —		
Engineering assistants,	\$2,141 67	
Labor,	33,102 75	
Automobiles,	221 56	
Brick, cement and lime,	478 27	
Castings, ironwork and metals,	956 58	
Freight, express and teaming,	18 29	
Fuel and lighting,	34 88	
Jobbing and repairing,	169 40	
Lumber,	1,509 42	
Machinery, tools and appliances,	567 70	
Paints and oils,	555 98	
Rubber and oiled goods,	91 60	
Sand, gravel and stone,	44 47	
Telephones,	60 12	
Traveling expenses,	955 79	
General supplies,	1,353 94	
Miscellaneous expenses,	421 39	
		42,683 81
Horses, vehicles and stable account,		5,973 14
Payments under Industrial Accident Law and special benefit appropriations,		3,082 00
Total for North Metropolitan System,		\$230,021 71

GENERAL CHARACTER OF EXPENDITURES.		For the Year ending December 31, 1918.	
<i>South Metropolitan System.</i>			
Administration: —			
Commissioners,		\$1,983 33	
Secretary and assistants,		1,911 25	
Rent,		198 90	
Heating, lighting and care of building,		227 81	
Repairs of building,		7 14	
Postage,		47 00	
Printing, stationery and office supplies,		350 63	
Telephones,		42 96	
Traveling expenses,		29 00	
Miscellaneous expenses,		35 83	
			\$4,833 85
General supervision: —			
Chief engineer and assistants,		\$4,772 28	
Rent,		596 70	
Heating, lighting and care of building,		683 56	
Repairs of building,		21 43	
Printing, stationery and office supplies,		117 21	
Telephones,		128 90	
Traveling expenses,		95 00	
Miscellaneous expenses,		55	
			6,415 63
Ward Street pumping station: —			
Labor,		\$26,394 66	
Fuel,		36,499 36	
Oil and waste,		425 87	
Water,		1,585 20	
Packing,		650 17	
Repairs and renewals,		2,487 07	
Telephones,		40 10	
General supplies,		1,556 58	
Miscellaneous supplies and expenses,		1,136 17	
			70,775 18
Quincy pumping station: —			
Labor,		\$9,707 87	
Fuel,		6,005 40	
Oil and waste,		96 62	
Water,		267 32	
Packing,		42 92	
Repairs and renewals,		109 09	
Telephones,		37 89	
General supplies,		426 13	
Miscellaneous supplies and expenses,		67 04	
			16,760 23
Nut Island screen-house: —			
Labor,		\$9,404 50	
Fuel,		4,220 00	
Amounts carried forward,		\$13,624 50	\$98,784 94

GENERAL CHARACTER OF EXPENDITURES.		For the Year ending December 31, 1918.	
<i>Amounts brought forward,</i>		\$13,624 50	\$98,784 94
<i>South Metropolitan System — Con.</i>			
Nut Island screen-house — <i>Con.</i>			
Oil and waste,	. . . . .	146 49	
Water,	. . . . .	376 89	
Packing,	. . . . .	24 11	
Repairs and renewals,	. . . . .	353 82	
Telephones,	. . . . .	45 80	
General supplies,	. . . . .	556 71	
Miscellaneous supplies and expenses,	. . . . .	158 50	
			15,286 82
Sewer lines, buildings and grounds: —			
Engineering assistants,	. . . . .	\$4,668 51	
Labor,	. . . . .	22,828 92	
Automobiles,	. . . . .	809 81	
Brick, cement and lime,	. . . . .	216 70	
Castings, ironwork and metals,	. . . . .	190 41	
Fuel and lighting,	. . . . .	47 24	
Freight, express and teaming,	. . . . .	4 53	
Jobbing and repairing,	. . . . .	805 20	
Lumber,	. . . . .	340 02	
Machinery, tools and appliances,	. . . . .	176 44	
Paints and oils,	. . . . .	258 95	
Rubber and oiled goods,	. . . . .	70 61	
Sand, gravel and stone,	. . . . .	196 56	
Telephones,	. . . . .	36 95	
Traveling expenses,	. . . . .	481 24	
General supplies,	. . . . .	429 12	
Miscellaneous expenses,	. . . . .	160 40	
			31,721 61
City of Boston, for pumping,	. . . . .		5,869 36
Horses, vehicles and stable account,	. . . . .		4,031 85
Payments under Industrial Accident Law and special benefit appropriations,			180 00
Total for South Metropolitan System,			\$155,874 58

(b) Receipts.

The receipts from the sales of property, from rents and from other sources, have been credited as follows: —

ACCOUNT.										For the Year ending December 31, 1918.
Construction: —										
North Metropolitan System,	.	.	.	.	.	.	.	.	.	\$31 70
South Metropolitan System,	.	.	.	.	.	.	.	.	.	30 70
Maintenance: —										
North Metropolitan System,	.	.	.	.	.	.	.	.	.	\$07 68
South Metropolitan System,	.	.	.	.	.	.	.	.	.	10,763 65
Sinking fund: —										
North Metropolitan System,	.	.	.	.	.	.	.	.	.	166 63
South Metropolitan System,	.	.	.	.	.	.	.	.	.	8 33
Interest fund: —										
North Metropolitan System,	.	.	.	.	.	.	.	.	.	42 47
South Metropolitan System,	.	.	.	.	.	.	.	.	.	33 81
Amount credited from beginning of work to January 1, 1918,										\$11,884 97
										138,778 80
Total receipts to January 1, 1919,										\$150,663 77

(c) Assets.

The following is an abstract of the assets of the Sewerage Works, a complete schedule of which is kept on file in the office of the Board: —

Office furniture, fixtures and supplies; engineering and scientific instruments and supplies; horses, vehicles, field machinery, etc.; machinery, tools and other appliances and supplies; completed works, real estate connected therewith.

(d) Liabilities.

There are bills for current expenses which have not yet been received.

Amounts on Monthly Estimates, not due until Completion of Contracts or until Claims are settled.

NAME.	Work.	Amount.
High-level sewer extensions: —		
Timothy J. O'Connell, . . .	Contract 57, Section 82, in part,	\$60 00
Rowe Contracting Co., . . .	Contract 139, Section 99 (in part), Wellesley Extension.	1,881 00

Settlements are pending with the following parties for easements taken in lands owned by them: —

F. Murray Forbes, Hugh D. Scott, Charles H. Harmon, Clifford M. Locke, Martha W. Burrage, Needham Tire Co., John Wells Farley, Edward and Catherine Bingham, Hannah Bingham, Katherine H. Rooney, Mary A. Read, Hannah E. Pond, Richard G. Wadsworth, John T. Morse, Jr., Frank D. Chase, Devisees of Anna E. Chase, Stephen M. Weld, Lucia Beebe, Edward F. Gilman, Herbert M. Hopkins, Joseph E. Hopkins, George A. Forbes, Bear Hill Associates.

VIII. RECOMMENDATIONS FOR LEGISLATION.

In the abstract of the annual report for the year 1918 the Board made the following statement and recommendations: —

In supplying the higher portions of Hyde Park and Milton it is necessary to use, in common with the Boston Water Department, a section of the pipe line about 2,200 feet in length located in Poplar Street in West Roxbury which belongs to the City of Boston. This has proved unsatisfactory at times and it is deemed necessary, in order to provide an adequate supply and to insure a reliable service for the Milton and Hyde Park extra high-service district, that a second pipe line should be laid in said street and under the Neponset River. The cost of this pipe line is estimated at \$14,000.

When the northern extra high-service supply was introduced into Arlington in 1899 the town granted this Department the right to use, in common with the town, water pipes belonging to the town as far as necessary for the purpose of conveying water to the standpipe and to the town of Lexington. Satisfactory service is not now furnished by the use of the Arlington mains in common, and it is desirable to lay a 16-inch Metropolitan Water Works main from the Arlington standpipe to the Lexington boundary line, a distance of about 6,000 feet. The cost of this 16-inch main is estimated at \$56,000.

The Legislature, by chapter 322 of the General Acts of 1917, authorized the construction of a new 36-inch water main about 1,800 feet in length in Chelsea to reinforce the East Boston supply main, and appropriated the sum of \$30,000 for the work. Some expenses have been incurred chargeable to this appropriation but there is a balance remaining on hand of \$29,820.86. It is estimated that, if this work is done in the coming year, the sum of \$40,000 will be required, which will require an additional appropriation for this purpose of \$11,000.

Attention has been called in all the reports of recent years to certain large expenditures in connection with some inevitable improvements and extensions of the metropolitan systems under the control of this Board. They are, fortunately, on the water supply system which yields a return more than sufficient to meet any expenditure which now seems requisite.

The plan submitted by the State Board of Health in 1895, and accepted by the Legislature of the same year, showed a direct line of communication between the proposed line to Weston and Spot Pond. As this connection could be avoided by pumping the Spot Pond supply from the Chestnut Hill reservoirs for a number of years, the Board has not hitherto brought the question before the Legislature, but it now seems advisable to give this plan serious attention. While it is quite true that there may be no interference with the operation of the pumps at Chestnut Hill, it is also true that the whole of the north system would be seriously impaired by their failure.

The direct connection between Weston and Spot Pond would remove the need of pumping the water supplied by the Weston system and would thus assure the maintenance of the Spot Pond reservoir under all conditions. Incidentally, this new line would afford a guarantee for the adequate supply of all the communities lying between Weston and Stoneham.

It is difficult to state the probable expense of this pipe line for two-thirds of the cost would be in the iron pipes and what that may be at the time when a contract might be made is uncertain. At present prices the pipe would cost approximately \$1,200,000 and labor and the incidentals of the work \$600,000.

The other proposed work is the replacement of the Arlington standpipe by a structure sufficient for the wants of this rapidly growing district which includes, in addition to Arlington, portions of Belmont and Lexington. The present standpipe was built by the town for its own use without reference to any requirements beyond the limits of the town and has become inadequate. It is proposed to replace this structure by one similar to that erected on Mt. Bellevue in West Roxbury for the southern extra high-service district. The estimates for this are, — for the tank, \$65,000, and for masonry, \$110,000. With the exception of the steel plates the work of building the tank and the masonry would be performed in this State by men employed here.

By chapter 343 of the Acts of 1914 the construction of the Wellesley Extension of the South Metropolitan Sewer was authorized and the sum of \$350,000 appropriated for the work. On account of the bad material encountered and the abnormal condition of the market in regard to labor and supplies this sum was found to be inadequate and on calling the attention of the Legislature to the situation a further appropriation of \$325,000 was authorized under the provisions of chapter 285 of the General Acts of 1917. Since the last-named appropriation was made there has been a still further substantial increase in the cost of labor and materials and some large claims for land damages have been presented which the Board has not felt justified in paying and upon which suits have been brought. It is estimated that the total cost to complete the work will be about \$340,000, exclusive of land damages and engineering expenses. There is a balance on hand from previous appropriations of \$125,000. The Board, therefore, recommends a further appropriation of \$225,000 and believes this amount will be sufficient to complete the work.

The Legislature admitted the town of Reading to the North Metropolitan Sewerage System by chapter 159 of the General Acts of 1916 and appropriated \$285,000 for the purpose of connecting the town with this system. All the

estimates made since that date show that the expense of constructing the sewer will very largely exceed the amount of the appropriation. An estimate made by a responsible contractor a year ago amounted to \$700,000. Whether conditions will be such as to make it probable that any reduction in this amount can now be expected is a matter upon which the Board is unable to give a satisfactory answer. For the completion of this work the Board recommends an additional appropriation of \$415,000.

The detailed reports of the Chief Engineer of Water Works and of the Chief Engineer of Sewerage Works, with various tables and statistics, are herewith presented.

Respectfully submitted,

HENRY P. WALCOTT,
EDWARD A. McLAUGHLIN,
JAMES A. BAILEY,

Metropolitan Water and Sewerage Board.

BOSTON, February 26, 1919.

REPORT OF CHIEF ENGINEER OF WATER WORKS.

To the Metropolitan Water and Sewerage Board.

GENTLEMEN: — I have the honor to submit a report of the work done in connection with the construction, maintenance and operation of the Metropolitan Water Works for the calendar year 1918.

ORGANIZATION.

The organization of the force employed under the direction of the Chief Engineer has remained the same as in 1917. The principal assistants are as follows: —

John L. Howard,	. . .	Assistant to Chief Engineer.
Elliot R. B. Allardice,	. . .	Superintendent of Wachusett Department.
Charles E. Haberstroh,	. . .	Superintendent of Sudbury Department.
Samuel E. Killam,	. . .	Superintendent of Distribution Pipe Lines and Reservoirs.
Arthur E. O'Neil,	. . .	Superintendent of Distribution Pumping Stations.
Alfred O. Doane,	. . .	Division Engineer, in charge of Mechanical Engineering and Inspection Work.
William W. Locke,	. . .	Sanitary Inspector, in charge of Sanitary Inspection of Watersheds.
Clifford Foss,	. . .	Assistant Engineer, in charge of Distribution Civil Engineering.
Benjamin F. Hancox,	. . .	Head Draftsman, in charge of Drafting Force.
James W. Killam,	. . .	Assistant Engineer, in charge of Coal and Oil Laboratory and compilation of Pumping Statistics.
William E. Whittaker,	. . .	Office Assistant, in charge of General Office and compilation of Water Supply Statistics.
Charles E. Livermore,	. . .	Biologist, in charge of Microscopical and Bacteriological Examinations of the Water Supply.

Including these principal assistants the number of supervising, engineering and clerical employees was 39 at the beginning of the year and 42 at the end of the year.

In addition to the office forces the labor forces engaged in maintaining and operating the reservoirs, aqueducts, pipe lines, hydro-electric stations and pumping stations and doing minor construction work have been as follows: —

DEPARTMENT.	Beginning of Year.	End of Year.	Maximum.	Average.
Wachusett,	49	41	65	50
Sudbury,	82	62	91	82
Distribution, pipe lines and reservoirs, . .	91	82	102	88
Distribution, pumping service,	61	70	71	65
	283	255	329	285

During the year 18 employees were mustered into the United States service.

CONSTRUCTION.

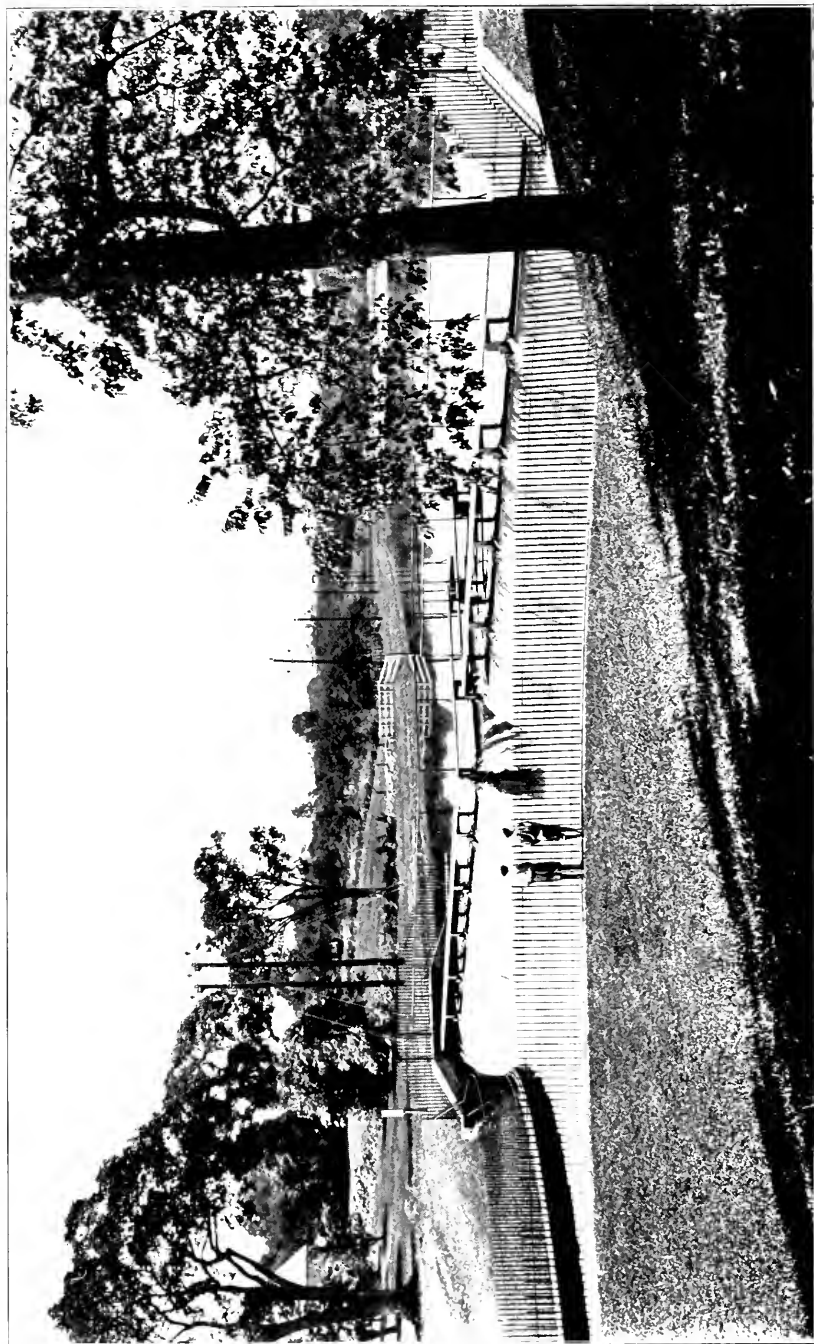
DEFERRED PROJECTS.

On account of the continued high prices of labor and materials work was not undertaken on the improvement of Beaver Dam Brook, which was authorized in 1913; on the 12-inch southern extra high-service pipe line and the 16-inch northern extra high-service pipe line, which were authorized in 1916, and on the 36-inch low-service pipe line that was authorized in 1917, as the appropriations for these projects were not sufficient to cover the cost of the work under the abnormal conditions due to the war.

WACHUSETT-SUDBURY TRANSMISSION LINE.

The Wachusett-Sudbury high-tension power transmission line, which extends for a distance of 15.59 miles over Water Works lands from the New England Power Company's high-tension line at a point near the Wachusett Dam in Clinton to the proposed out-door transformer station, which is being constructed by the Edison Electric Illuminating Company of Boston at the Sudbury Dam in Southborough, is designed for 66,000-volt service and has been constructed in order to dispose of the entire output from the Wachusett power station for a period of ten years. Details of construction of the line were fully described in my last annual report.

The contract work remaining to be done at the close of the year 1917 included some field riveting of the steel towers, the placing of



SPECIAL DOUBLE-POLE STRUCTURE ON WACHUSETT-SUDBURY POWER TRANSMISSION LINE AT THE LOWER DAM
OF THE WACHUSETT AQUEDUCT IN SOUTHBOROUGH.

the insulators, the stringing of the power and telephone conductors and the final painting of the poles and towers.

The riveting of the towers was completed January 10 and work was then suspended until April 22 when it was resumed and prosecuted continuously with a small force until completed on July 3.

The private telephone line which was constructed in connection with the power line was completed by the department forces, the connections being made into the power stations through underground conduits. Telephone instruments were installed at the power station and the storage yard in Clinton and at the tool-house near the terminal chamber of the Wachusett Aqueduct in Marlborough, and at the Sudbury power station in Southborough. The telephone line was put into service on August 3.

The switchboard at the Sudbury power station has been rewired so that the spare 15,000-volt underground cable can be connected with the new transmission line while the other remains connected with the Hopkinton line.

The structures along the power line have been numbered consecutively from the Clinton to the Southborough ends of the line and the towers have been marked with enameled iron and the poles with aluminum danger tags.

As there appeared to be no prospect of the Edison Electric Illuminating Company completing its connecting line until the following year, the Wachusett-Sudbury line was temporarily grounded at four points after completion to protect it from lightning.

At midnight December 31 the maintenance of the transmission line was turned over to the electric companies, according to the provisions of the contract for the sale of the electric energy generated at the Wachusett power station, which is to be in force for a period of ten years from said date.

The cost of the transmission line, exclusive of administration and the clearing of the location, which was done by the regular maintenance force, is as follows: —

Contract for constructing line and furnishing all materials except	
200 poles,	\$74,875 14
Cutting and delivering 200 poles,	1,527 76
Extension of telephone line to power stations, etc.,	1,217 06
Real estate and conveyancing,	805 84
Engineering,	3,351 72
	<hr/>
	\$81,777 52

ADDITIONAL NORTHERN EXTRA HIGH-SERVICE PUMPING MACHINERY.

At the northern extra high-service pumping station in Arlington the work of installing the steam turbine driven centrifugal pumping unit of a capacity of 3,000,000 gallons in 24 hours and the horizontal return tubular boiler 54 inches in diameter by 17 feet in length has been completed and the coal pocket has been extended to obtain increased storage capacity.

The pumping unit was first operated on April 8 and the official duty trials made on May 7, 8 and 9. The unit consists of a Moore multi-stage condensing steam turbine of 260 brake horse power rating at 125 pounds steam pressure, connected through speed reducing gears with two Allis-Chalmers single-stage 8-inch centrifugal pumps in series. The nominal speed of the turbine is 5,000 revolutions per minute for the rated capacity of 3,000,000 gallons in 24 hours against a head of 320 feet.

The condensing equipment, which was built by the Wheeler Condensing & Engineering Company, consists of a surface condenser of the water works type, with a cooling surface of 600 square feet, and an independent air pump of the crank and fly-wheel type.

The results of the official duty trials, which were of eight hours' duration, at one-third, two-thirds, and full capacity are as follows:—

	One-third Capacity.	Two-thirds Capacity.	Full Capacity.
Average pressures:—			
Atmospheric (pounds per square inch),	14.530	14.475	14.628
Steam, absolute (pounds per square inch),	140.460	140.085	140.078
Vacuum (inches of mercury of standard density),	28.432	28.288	28.382
Absolute in condenser (pounds per square inch),	0.617	0.582	0.688
Average temperatures:—			
Air in engine-room (degrees Fahrenheit),	92.60	84.59	79.76
Air in basement (degrees Fahrenheit),	80.00	75.38	72.59
Air outside station (degrees Fahrenheit),	91.40	75.59	67.18
Water pumped:—			
At condenser inlet (degrees Fahrenheit),	56.10	61.00	64.53
At condenser outlet (degrees Fahrenheit),	59.50	63.00	67.18
Work done:—			
Average discharge head (feet),	433.64	453.80	461.00
Average suction head (feet),	153.88	153.41	140.04
Average head pumped against (feet),	279.76	300.39	320.96

	One-third Capacity.	Two-thirds Capacity.	Full Capacity.
Work done— <i>Con.</i>			
Water pumped:—			
Total in 8 hours (by Venturi meter, gallons),	351,100	673,600	1,013,700
Total weight (computed, pounds),	2,927,305	5,614,360	8,445,240
Average rate per 24 hours (gallons),	1,053,300	2,020,800	3,041,100
Average speed of pumps (observed revolutions per minute),	1,455	1,526	1,655
Work done during 8-hour trial (foot-pounds),	818,942,600	1,686,491,000	2,710,530,000
Steam used:—			
By turbine (pounds),	14,269.400 ¹	20,593.000 ²	29,635.000 ³
By air pump (pounds),	484.500	479.700	494.250
Total (pounds),	14,753.900	21,072.700	30,129.250
Average moisture (per cent.),	1.736	1.236	4.637
Heat used:—			
By turbine (B. T. U.),	16,024,650	23,252,200	32,431,180
By air pump (B. T. U.),	483,390	480,818	480,555
Total (B. T. U.),	16,508,040	23,733,018	32,911,735
Duties:—			
Per 1,000,000 British thermal units (contract basis, foot-pounds),	49,608,700	71,061,200	82,359,200
Per 1,000 pounds of moist steam (foot-pounds),	55,506,900	80,032,277	89,965,200

¹ Including 10.4 pounds for steam seal at turbine shaft.² Including 20 pounds for steam seal at turbine shaft.³ Including 11 pounds for steam seal at turbine shaft.*Summary of Results.*

	Foot-pounds per Million British Thermal Units.
One-third capacity duty,	49,608,700
Two-thirds capacity duty,	71,061,200
Full capacity duty,	82,359,200
Average duty,	67,676,400
Average duty guaranteed,	60,000,000
Excess duty above guarantee,	7,676,400
Additional compensation for excess duty provided by contract,	\$700.00

The new horizontal return tubular boiler is 54 inches in diameter and contains 60 charcoal iron tubes 3 inches in diameter and 17 feet long, and a working steam pressure of 160 pounds per square inch is allowed. The boiler was delivered at the pumping station

March 18 and is set in battery with the two similar boilers which were installed when the station was built in 1907. The brick setting for the boiler was built by the department forces and was completed June 29.

Two Coppus blowers, one 12 inches and the other 14 inches in diameter, were installed so that forced draft can be used with any of the boilers. The grate is 4 feet wide x 5 feet 6 inches long, with $\frac{1}{4}$ -inch air spaces, and was made by the New England Roller Grate Company.

A second line of main steam pipe, most of it 4 inches in diameter, was installed and connected with all of the boilers and engines. The steam piping is now arranged so that any one or all of the engines can be supplied with steam through either or both steam pipes.

A 3-inch Cochrane separator was installed at the throttle valve of the new engine and a No. 9 Whitlock coil heater is connected with the exhaust pipe of the air pump to heat the boiler feed water.

The coal pocket extension is $31\frac{1}{2}$ feet long x 28 feet wide x $9\frac{1}{2}$ feet high, and equivalent in size to the old pocket, so that the storage capacity has been doubled. The pocket is constructed of concrete masonry, except the exposed exterior, which is of Weymouth seam face and Deer Isle granites to match the lower portion of the pumping station. The pocket is located under the existing side-track and coal can be dumped into it directly from the cars through hatches in the roof. The construction of the new pocket was begun April 4 and was practically completed at the close of the year. Most of the work was done by the department forces.

The cost of the improvements at the pumping station, exclusive of administration, is as follows:—

Engine,	\$9,700 00
Engine foundation and additional work,	561 52
Boiler,	2,324 51
Boiler setting and additional work,	1,984 70
Coal pocket excavation and concrete walls and roof,	5,211 03
Coal pocket, granite facing,	1,739 00
Piping,	2,628 40
Miscellaneous work,	1,525 98
Engineering,	2,240 40
	<hr/>
	\$27,915 54

DUPLICATE SOUTHERN EXTRA HIGH-SERVICE PIPE LINE UNDER
NEPONSET RIVER IN HYDE PARK.

A contract was made with the United States Cast Iron Pipe & Foundry Company on June 26, 1918, for furnishing 12-inch flexible jointed pipes for the southern extra high-service line under the Neponset River at West Street in Hyde Park, which was authorized in 1916. On account of delay in delivery the pipes were not received until November 23, and as the weather was then unfavorable for laying the pipe the work was postponed and will not be undertaken until the weather is favorable in the spring of 1919. The pipe line will be about 365 feet in length.

ADDITIONAL 20-INCH PIPE LINE FOR WATERTOWN AND BELMONT.

On account of the large increase in the quantity of water used in Watertown, due to the greatly increased activity at the United States Arsenal and at several factories in the vicinity, it became necessary to construct an additional supply main in order to maintain satisfactory service in Watertown and Belmont.

The new main was authorized April 26 by chapter 177 of the General Acts of 1918. It extends from the 36-inch southern high-service main through Commonwealth Avenue, Newton, to Lake Street, and thence through Lake Street, private land, Fairbanks Street and Brooks Street in Brighton, to and across the North Beacon Street bridge into Watertown.

The pipe line is 20 inches in diameter for a distance of 9,664 feet and is reduced to 16 inches in diameter for a distance of 503 feet to cross the bridge in the limited space available.

Contract for the pipes was made with the United States Cast Iron Pipe & Foundry Company on May 1, 1918, and the contract for laying the pipes was made with Michele DeSisto May 29. Pipe laying was begun June 3 and was continued at the specified rate until September 7. Work was then suspended until September 30 on account of delay in receiving pipes from the foundry. Pipe laying was completed October 18 and the contract work was entirely completed on October 28. The average force employed on pipe laying was 32 men and 4 horses.

Following the practice begun in 1909, insulating joints were installed in the pipe line about 500 feet apart to reduce the damage to

the distribution pipes by electrolytic action produced by the underground electric currents from the street railways.

The pipe line was filled with water and tested by the department forces, and after draining and refilling was put into service November 7. The resulting increase of pressure was 25 pounds per square inch at the Arsenal, 15 pounds per square inch at Watertown Town Hall and about 12 pounds per square inch in Belmont.

The cost of the work, exclusive of administration, is as follows:—

Pipes and special castings,	\$56,351 37
Laying pipe,	31,330 21
Municipal work on underground structures and resurfacing streets,	3,403 58
Work done by department force installing wooden joints and air valves, testing and filling pipe line and miscellaneous work,	986 74
Engineering and preliminary,	4,725 10
Real estate and conveyancing,	1,323 75
	<hr/>
	\$98,120 75

MAINTENANCE.

RAINFALL AND YIELD OF WATERSHEDS.

The annual precipitation was below the average on all of the watersheds, being 39.77 inches on the Wachusett watershed as compared with an average of 44.68 inches and a minimum of 37.26 inches for the past twenty-two years; 40.54 inches on the Sudbury watershed as compared with an average of 44.51 inches and a minimum of 32.78 inches for the past forty-four years; and 39.04 inches on the Cochituate watershed as compared with an average of 45.12 inches and a minimum of 31.20 inches for the past fifty-six years.

The monthly precipitation on the Wachusett watershed was below the average except in February, June and September, and on the Sudbury watershed it was below the average except in April, June, July and September. The large precipitation of September, amounting to 7.18 inches on the Wachusett watershed and to 8.60 inches on the Sudbury watershed, and the small precipitation in May and October are noticeable variations from the normal monthly precipitation.

The monthly yield from the Wachusett watershed was below the average for the past twenty-two years, except in February, March and September. The yield for the year was 902,000 gallons per day per square mile, which is 85.5 per cent. of the average for the past twenty-two years. The minimum annual yield during this period was 682,000 and the maximum 1,551,000 gallons per day per square mile. The yield from the Sudbury watershed was 736,000 gallons

per day per square mile, which is 75.49 per cent. of the average for the past forty-four years. The minimum annual yield during this period was 514,000 and the maximum 1,697,000 gallons per day per square mile. The yield of the Cochituate watershed was 758,000 gallons per day per square mile, which is 82.75 per cent. of the average yield for the past fifty-six years. The minimum annual yield during this period was 465,000 and the maximum 1,510,000 gallons per day per square mile.

During March and April the city of Worcester turned 583,400,000 gallons of water into the Wachusett watershed from the 9.35 square miles formerly in the Wachusett Reservoir watershed which it took for its water supply in 1911, and by agreement the city is entitled to compensation from the Commonwealth for this water as the Wachusett Reservoir did not fill during the year.

STORAGE RESERVOIRS.

The capacities of the storage reservoirs of the Metropolitan Water Works, the elevation of the water surfaces and the quantity of water stored in each reservoir at the beginning and at the end of the year are shown by the following table:—

STORAGE RESERVOIRS.	Elevation ¹ of High Water.	Capacity (Gallons).	JAN. 1, 1918.		JAN. 1, 1919.	
			Elevation ¹ of Water Surface.	Amount stored (Gallons).	Elevation ¹ of Water Surface.	Amount stored (Gallons).
Cochituate watershed:—						
Lake Cochituate, ² . . .	144.36	2,097,100,000	141.91	1,524,600,000	142.91	1,755,400,000
Sudbury watershed:—						
Sudbury Reservoir, . . .	260.00	7,253,500,000	257.52	6,225,200,000	258.24	6,520,600,000
Framingham Reservoir No. 1, . . .	169.32	289,900,000	167.71	216,500,000	167.87	223,400,000
Framingham Reservoir No. 2, . . .	177.87	529,900,000	176.02	482,600,000	176.20	490,300,000
Framingham Reservoir No. 3, . . .	186.74	1,180,000,000	183.25	920,300,000	185.09	1,066,200,000
Ashland Reservoir, . . .	225.21	1,416,400,000	223.59	1,327,900,000	224.50	1,377,300,000
Hopkinton Reservoir, . . .	305.00	1,520,900,000	303.30	1,415,100,000	304.18	1,469,600,000
Whitehall Reservoir, . . .	337.91	1,256,900,000	336.79	1,040,000,000	336.90	1,061,100,000
Farm Pond,	159.25	167,500,000	157.75	88,200,000	158.12	107,500,000
Wachusett watershed:—						
Wachusett Reservoir, . . .	395.00	64,968,000,000	385.94	53,225,600,000	381.88	48,426,600,000
Totals,	—	80,680,100,000	—	66,466,000,000	—	62,498,000,000

¹ Elevation in feet above Boston City Base.

² To top of flash-boards.

² Excluding Dudley Pond which was abandoned April 3, 1916.

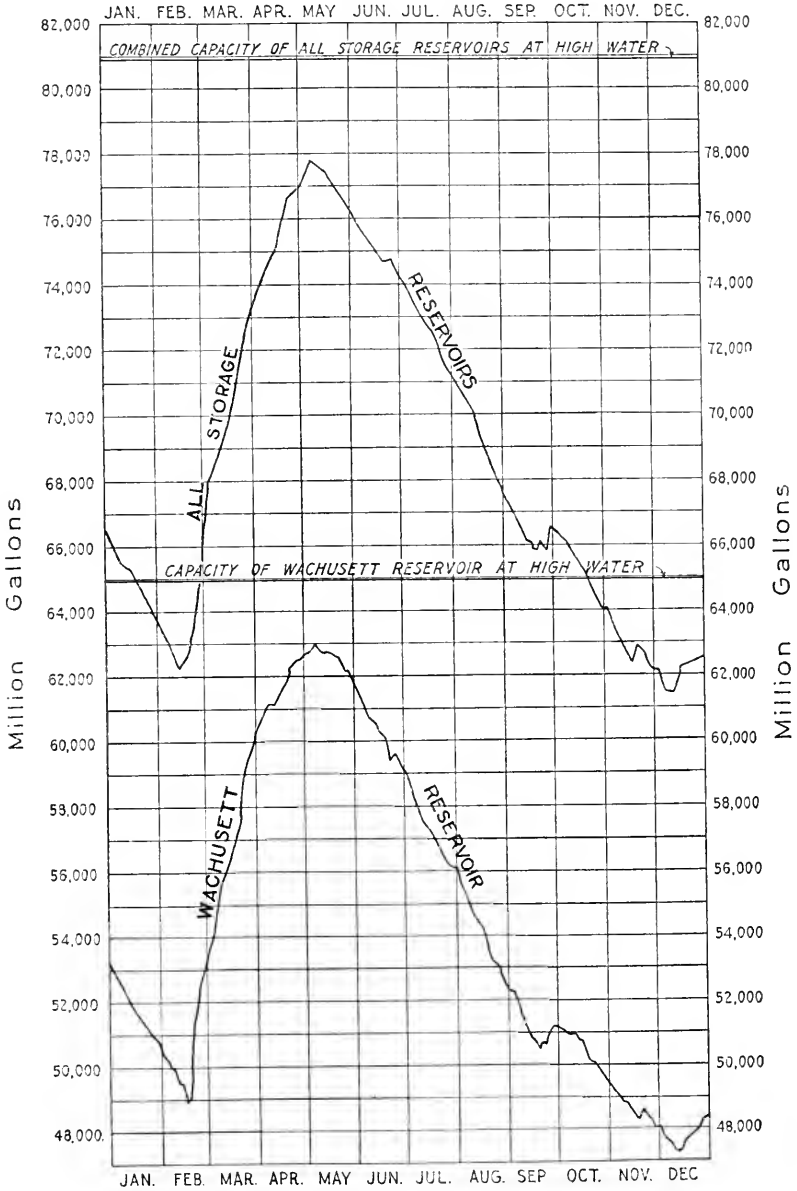
The diagram on page 57 shows the quantity of water stored in the Wachusett Reservoir and the quantity stored in all the storage reservoirs combined during the year.

The table and diagram show the total storage which could be drained from the reservoirs. Special provisions would be necessary, however, to draw about 10,000,000,000 gallons of this storage for consumption as it is below the outlet channels which can be conveniently used for regular service.

Wachusett Reservoir. — At the beginning of the year the Wachusett Reservoir contained 53,225,600,000 gallons of water and the surface of the water was at elevation 385.94, approximately 9 feet below high-water line. On account of the large consumption, due to the extremely cold weather, the water was drawn down rapidly and stood at elevation 382.29 on February 16. With the spring rains and thaws the water rose rapidly until May 6 when it was at elevation 393.50, which was the highest point reached during the year, and 1½ feet below high-water mark. The reservoir then contained 62,959,000,000 gallons of water, which subsided under the constant draft for water supply at a rate of about 2½ feet per month until September 16. On account of the heavy precipitation the water in the reservoir remained at a nearly constant level during the following month and then subsided at a nearly uniform rate until December 13, when it stood at elevation 380.77, which was the lowest point reached during the year and the reservoir then contained 47,171,200,000 gallons of water. From December 13 to the end of the year the water rose gradually to elevation 381.88 and the reservoir then contained 48,426,600,000 gallons of water.

During the year 1,087,200,000 gallons of water was discharged from the reservoir through the pool below the dam and through the pipe line to the Lancaster Mills, in accordance with the provisions of section 4 of chapter 488 of the Acts of the year 1895, which requires that not less than 12,000,000 gallons, and such further quantity not exceeding 12,000,000 gallons as the owners of the mills shall deem necessary, shall be allowed to flow from the reservoir during each week. The amount of water furnished to the mills is 211,400,000 gallons less than during the previous year. This reduction was brought about by notifying the mill officials that their requirements were at times in excess of the amount provided by statute and, as a result, in September they made extensive repairs and alterations in

QUANTITY OF WATER STORED IN THE WACHUSETT RESERVOIR
AND IN ALL THE STORAGE RESERVOIRS COMBINED
DURING 1918



their canal which stopped a large amount of leakage, and the saving for an entire year should be about 625,000,000 gallons.

During March and April the emergency pumping station of the city of Worcester, located on the shore of the reservoir at south bay in Boylston, which was erected in 1911, was dismantled and removed by city employees. The foundations and intake pipes were allowed to remain for the present. The station was used on 15 days during January, 1915, which is the only use made of it since November 10, 1911, when the emergency for which it was constructed ended.

Miscellaneous débris brought into the upper basins of the reservoir during the high water flow in the spring was collected and disposed of at a cost of \$128.51. Brush and weeds were mowed, raked into piles and burned along the sides of the highways adjoining water works lands, along the brooks flowing directly into the reservoir, along a portion of the margin of the reservoir and at the North and South dikes. This work extended over a distance of about 37 miles and cost \$1,706.10.

The 10-ton motor scow used in connection with the work around the reservoir, for the transportation of men, horses and materials, was in use from the spring until the late fall. Before placing the scow in service it was necessary to make extensive repairs as the seams had opened to such an extent that the calking would not hold. It was necessary to fit narrow strips of thin white pine over the seams and fasten them to the planking with brass wood-screws; the joints were then made up with "Sealtite," a plastic asphaltum and asbestos cement. The scow was then painted inside and outside. The cost of the work was \$151.59.

The Wachusett Dam is in good condition, with the exception of the granolithic walk across the top. The planking in the bridge at the waste-weir and the roofs of the gate-chamber and the power station require extensive repairs. Temporary repairs have been made to the roof of the power station in order to protect the machinery until permanent repairs are made. A large tar-paper-lined wooden drip-pan about 14 feet x 26 feet was placed in the loft of the station about a foot beneath the upper side of the roof and directly over the switchboard and the controlling electrical apparatus arranged so as to catch the water as it drips through the roof and conduct it to the leaders at the eaves.

The iron, picket and rail fences about the dam, waste-weir and

waste channel and the iron flash-board standards and bridge supports on the waste-weir have been painted one coat of Smith's Durable Metal Coating.

The exterior and interior woodwork of the garage and the exterior woodwork of the power station have been painted.

On account of the scarcity of labor an Ideal power lawn mower, fitted with a heavy lawn roller, was purchased early in June for use in connection with the care of the lawns about the dam, and has given entire satisfaction.

The tenements on the reservoir lands and the buildings at the Clinton and Oakdale storage yards have been given such attention as was necessary to keep them in good condition. At the Kramer house, near the Wachusett Dam, Clinton, the cellar walls were reinforced with concrete footings to keep out drainage and rats, at a cost of \$62.40. At the Cook place, Lancaster Street, West Boylston, the exterior of the house, barn and garage were given two coats of paint; a new cesspool was constructed and plumbing and drains remodeled, and the barn cellar was prepared for storage purposes. The cost of this work was \$494.03. At the Kendall place, Main Street, Boylston, the work of razing the large barn, repairing the other buildings and improving the grounds, which was begun in 1917, was completed at a cost of \$992.35.

Standing grass was sold at auction from about 350 acres of water works land bordering on the reservoir and tributary streams. The total receipts from the sale amounted to \$1,386.75.

Sudbury Reservoir. — The water in the Sudbury Reservoir was at elevation 257.52, approximately $1\frac{1}{2}$ feet below the crest of the overflow, at the beginning of the year and was kept at least one foot below the crest until the flash-boards were put in place April 9, and was not then allowed to rise above the crest of the overflow until July. It then fluctuated above and below the crest until the flash-boards were removed on November 18. The water was then kept at about elevation 258.00 until the end of the year.

The usual attention has been given to the care of the reservoir lands and structures. The shores of the reservoir were cleaned and the débris which had collected in the coves was removed. Gravel was screened and placed on the driveways, the walks at the dam were weeded and loam was spread on the outer slope of the dam embankment. The shrubs at the entrance to the driveway were

pruned as usual and, together with the apple trees at the northerly end of the dam, were sprayed with Scalecide to protect them from insects. A channel was cut in the ice back of the overflow at the dam and was kept open during the cold weather to protect it from ice pressure. Snow was removed from the sidewalks adjacent to the water works land on Maple Street in Marlborough, and from the walks and steps at the Sudbury Dam. The flash-boards and standards on the overflow of the dam, the ironwork of the interior and exterior of the meter chamber, including the meter registers, and the iron railings of the bridge over the open channel below the dam were painted and part of the stone coping of the bridge which had settled was reset to grade. Minor repairs were made to the house and barn at the dam. The sprouts and brush were mowed in the 5-foot lanes along the land lines for a distance of 3.25 miles at a cost of \$36.

Framingham Reservoir No. 3. — All the water delivered through the Sudbury Aqueduct for the supply of the Metropolitan Water District, was drawn from Framingham Reservoir No. 3, which was replenished with water from the Sudbury Reservoir as required. During the winter the water was kept below the crest of the overflow, between elevations 182 and 185, and during the warm weather the water was kept near the crest, between elevations 183 and 186. The flash-boards were kept on the overflow throughout the year and no water was wasted from the reservoir either through the gates or over the flash-boards. Sprouts and brush were mowed in the 5-foot lanes along property lines for a distance of $2\frac{1}{2}$ miles, and brush which was growing at various points along the shores of the reservoir was mowed and the embankments and gate-houses were given the usual care.

Framingham Reservoirs Nos. 1 and 2, Ashland, Hopkinton and Whitehall Reservoirs. — No water was drawn from these reservoirs for supplying the Metropolitan Water District during the year. During the winter and early spring the flash-boards were removed from the crests of the dams, except at Whitehall Reservoir which has no overflow. Water was wasted, when necessary to maintain the desired elevation, over the crests of the dams except at Whitehall Reservoir where it was wasted through the gates. The water was lowered somewhat in all of these reservoirs, except in Framingham Reservoir No. 1, during the early spring by wasting through the

gates so that the freshet flows could be controlled properly. During the remainder of the year, when the flash-boards were in position, if the waste could not be easily regulated by the removal or replacement of a few flash-boards, the water was wasted through the gates when necessary to prevent the reservoirs from filling above the desired elevation.

A discharge of not less than 1,500,000 gallons of water per day was maintained throughout the year from Framingham Reservoir No. 1 into the Sudbury River, as required by the provisions of chapter 177 of the Acts of the year 1872. Water was also discharged in larger quantities from time to time, as required, to dispose of a portion of the yield of the watershed above Dam No. 1 which could not be stored in the reservoirs.

The usual attention was given to the dams, gate-houses and structures at these reservoirs.

A new fence, consisting of two rails 2 inches x 6 inches supported by wooden posts, was built along both sides of Fountain Street where it passes through Framingham Reservoir No. 2 and within the limits which we are required by agreement with the town of Framingham to keep in repair. The total length of fence built was 2,088 feet. It was given two coats of paint. The cost of the work was \$375 for labor and \$408.15 for materials.

At the Ashland Reservoir the new barn 30 feet x 30 feet in plan for the use of the gate-keeper, the construction of which was begun last year, was completed. Provision has been made for storing hay and housing wood and teams, and stalls have been constructed for two cows and a horse. The building takes the place of three old buildings which were torn down. The appearance of the grounds has been greatly improved by the removal of the old buildings and the grading of the grounds around the new barn and the extension of the driveway. A trellis for climbing vines and a lattice were constructed to screen the clothes yard and outbuildings. All of this work was done by the regular department force.

Brush was mowed and burned along the waste channel below the dam. Sprouts and brush were mowed in the 5-foot lanes along property lines for a distance of 4.4 miles.

At the Hopkinton Reservoir the upper portion of the chimney in the gate-keeper's house at the dam was taken down and rebuilt to remove an offset which caused creosote from the burning wood to

ooze through the chimney and stain the paper and plastering in some of the rooms.

Brush was mowed and burned along the waste channel below the dam, and sprouts and brush were mowed in the 5-foot lanes along property lines for a distance of 6.5 miles.

At Whitehall Reservoir brush was mowed and burned in the 5-foot lanes along property lines for a distance of 5.7 miles. One cottage was built at this reservoir by an adjoining property owner and there are now 65 cottages located on the shores of the reservoir. There were 8 motor boats, 92 row boats and 26 canoes in use on the reservoir during the summer, a total of 126, which is 9 more than in 1917.

Brush was mowed and burned in the 5-foot lanes along property lines for a distance of 19.5 miles in Cedar Swamp and along the Sudbury River just below the Rocklawn Mills.

Farm Pond. — Although Farm Pond is not used as a source of supply for the Metropolitan Water District the water therein has been kept within about one foot of high-water line throughout the year by supplying it with water from Framingham Reservoirs Nos. 1 and 2 on June 26, to accommodate the town of Framingham, which obtains a portion of its water supply from the filter-gallery located on the easterly shore of the pond. No water was wasted from the pond during the year. Under the rights reserved by legislation the town of Framingham pumped 196,600,000 gallons of water from the filter-gallery and the Boston & Albany Railroad took approximately 77,300,000 gallons and the New York, New Haven & Hartford Railroad took approximately 71,500,000 gallons directly from the pond for use during the year.

Lake Cochituate. — At the beginning of the year the water in Lake Cochituate was at elevation 141.57, approximately $2\frac{3}{4}$ feet below high-water line. Water was drawn from the lake through the Cochituate Aqueduct for consumption in January and February and was wasted at the outlet dam during every other month in the year to maintain the desired elevation.

Minor repairs and improvements were made in the drains at the foreman's house and at the barn and shop and carriage and tool sheds. The iron and wood work in the effluent gate-house were given two coats of paint and the tin roof one coat. The shop, wagon-shed, doors and window frames of the barn were given two coats of paint.

During the year the débris which collected in the coves around the lake was removed. The grass and brush on both sides of the open channel portion of the surface water drain from Cochituate Village was mowed for a width of 10 feet and sediment was removed from the catch basins, open channel and sand catcher at Bannister's Brook. Brush was mowed in the 5-foot lanes along property lines for a distance of 6 miles.

During the year ten cottages were built by adjoining property owners and one cottage was burned. There are now one hundred and thirty-three cottages, fifteen garages and one stable on the adjoining lands.

AQUEDUCTS.

Wachusett Aqueduct. — Water was discharged through the Wachusett Aqueduct from the Wachusett Reservoir on 298 days. The total time that the aqueduct was in use is equivalent to 126 days, 2 hours and 4 minutes. The total quantity of water discharged was 39,663,500,000 gallons, equivalent to an average of 108,667,000 gallons per day for the entire year.

The Westborough State Hospital pumped 59,767,000 gallons of water during the year, equivalent to a consumption of 163,700 gallons per day, from the aqueduct at the terminal chamber.

The masonry aqueduct, open channel and appurtenances are in good condition with the exception of the Assabet Bridge. The granolithic walk on top of the bridge is in poor condition and should be relaid, and there is some leakage from the aqueduct at the westerly end of the bridge. The interior and exterior iron and wood work of the terminal chamber have been cleaned and painted, and the slate roof and copper gutters repaired. The iron railings and picket fences at the Assabet Bridge, at the upper and lower dams and at eight highways were painted with Smith's Durable Metal Coating, and the exterior of the barn and tool-house near the terminal chamber has been painted.

A Wheelock wire fence, 900 feet in length, was erected on the property line at land of James A. McHale in Southborough, and another 907 feet in length at the H. V. Perry land in Northborough, to replace the original board rail fence erected in 1897. New posts were set and the Wheelock wire fence erected in 1909 was restrung for a length of 865 feet on the property line at land of Charles F. Leland in Southborough. New posts were set and the wire fence erected in

1897 was restrung for 1,118 feet on the property line between pasture land under the control of the Westborough State Hospital and water works land in Big Crane Swamp in Westborough. An old stone wall on the property line at land of James B. Johnson in Little Crane Swamp in Northborough was rebuilt and topped with three strands of wire fencing for a distance of 273 feet.

Brush, grass and weeds have been mowed and disposed of for a distance of 10 miles along the aqueduct at a cost of about \$96 per mile.

A Ford automobile, fitted with a light truck body, was purchased in March for the use of the foreman in charge of work along the lower 6 miles of the aqueduct and the 15 miles of swamp drainage ditches tributary to the open channel.

Sudbury Aqueduct. — During the year the Sudbury Aqueduct was in service for conveying water from Framingham Reservoir No. 3 to Chestnut Hill Reservoir with the exception of nine hours on June 26, when the flow was stopped for the purpose of filling Farm Pond with water from Framingham Reservoirs Nos. 1 and 2 through the supply aqueduct. The total quantity of water discharged through the aqueduct to Chestnut Hill Reservoir was 27,241,200,000 gallons, equivalent to an average of 74,633,000 gallons per day for the entire year, which is 19,080,000 gallons per day more than in 1917.

A hot water heating system was installed for the garage near the Framingham office, the heater being put in a concrete addition in the rear of the garage but without any opening into the garage.

The culverts along the aqueduct were kept free from snow and ice during the winter, and brush, grass and weeds were mowed along the aqueduct land where this work is not done by the adjoining owners.

Weston Aqueduct. — Water was supplied from the Sudbury Reservoir to the Weston Reservoir through the Weston Aqueduct on 314 days during the year. The total time that the aqueduct was in service was equivalent to 187 days, 17 hours and 11 minutes. The total quantity of water discharged was 18,436,700,000 gallons, equivalent to an average of 50,512,000 gallons per day for the entire year, which is 1,567,000 gallons per day less than for the previous year.

As the Weston Aqueduct is now used in connection with the Sudbury power station, which is not operated on Sundays or holi-

days, except under unusual circumstances, the total flow for each week was discharged between 7 A.M. and 11 P.M. until April 29, and since then between 6.45 A.M. and 10.45 P.M. on the other days.

The exterior and interior ironwork at the head-house and manhole covers along the aqueduct were painted. The iron braces supporting the baskets on the screens in the head-house had rusted out and new braces were put in and the lower part of the screens was otherwise repaired. It is noticed that the screens deteriorate more rapidly with the intermittent flow which is maintained in the aqueduct in connection with the operation of the power station than formerly when a continuous flow was maintained.

The exterior of the house at the White place in Nobscot was given two coats of paint and new steps were built at the rear porch. In the interior of the house the woodwork in the kitchen, dining room and two bedrooms was given one coat of paint.

Sprouts and brush were mowed in the 5-foot lanes along property lines for a distance of 0.64 of a mile near the White place.

The culverts along the aqueduct were kept free from snow and ice during the winter. Short lengths of fences were repaired by setting new posts at several places.

Cochituate Aqueduct. — The Cochituate Aqueduct was in use on three days in January and nine days in February, a total of twelve days during the year for conveying water to Chestnut Hill Reservoir. The total time that the aqueduct was in use is equivalent to 11 days and 2 hours. The total quantity of water discharged was 154,500,000 gallons.

The culverts along the line were kept free from snow and ice during the winter months. A Wheelock wire fence was built for a distance of 968 feet near North Main Street, Natick, along Snake Brook, to prevent cattle in the adjoining pasture from entering the brook.

The Newton & Watertown Gas Light Company laid a line of 12-inch pipe across the aqueduct on the southerly side of Commonwealth Avenue, between Furber Lane and Center Street in Newton. The pipe was laid with leaded joints for a distance of 96 feet where it crosses the aqueduct.

SANITARY INSPECTION OF WATERSHEDS.

The Sanitary Inspector and an assistant have made the usual investigations of conditions on the Wachusett, Sudbury and Cochituate watersheds for the purpose of protecting the water supply from pollution. A summary of the work is given in the accompanying tables.

Ice cutting operations were inspected at the various reservoirs and ponds during the winter and special watchmen were employed during the summer to prevent bathing and unauthorized boating or fishing in the reservoirs.

Wachusett Watershed.

The Mount Pleasant House, in Jefferson, which had formerly been kept open during the entire year, was closed November 1. The sand filter-beds constructed by the department in 1905 to purify drainage from this hotel have given good results and were operated satisfactorily during the extreme cold weather in January, February and March by the proprietor.

There are now many farms on the watershed occupied by the owners only during the summer, the principal operation being the harvesting of the hay crops.

The mills at Jefferson, Dawson and Quinepoxet have been very busy on war orders during the past year and such attractive wages were paid, even for unskilled labor, that many small farms were temporarily abandoned which will probably be occupied again when the unusual demand for labor in the mills ceases.

Three coal pockets and a small office have been built at the Warren tannery site in Holden. The sanitary conditions at this place are now satisfactory.

There were 12 new buildings constructed on the watershed during the year and as 2 were eliminated there has been an increase of only 10 premises, making a total of 1,740 at the end of the year.

There was no case of typhoid fever reported on the watershed during the year.

Summary of Sanitary Inspections on the Wachusett Watershed in 1918.

DISTRICT.	Number of Premises In- spected.	CLASSIFICATION OF CASES INSPECTED.												CONDITION AT END OF YEAR.		WATER SUPPLY.			
		Cesspools dug before 1918.	Cesspools dug during 1918.	Direct Privy Drain- age.	Indirect Privy Drain- age.	Direct Sink Drainage.	INDIRECT SINK DRAINAGE.		BARN DRAINAGE.		Manufacturing Wastes.	Premises Vacant.	No Drainage.	Drainage carried to Filter-beds.	Satisfactory.	Unsatisfactory.	Premises having Pub- lic Supply.	Premises having Pri- vate Supply.	Premises on which no Water is used.
							Satisfactory.	Unsatisfactory.	Satisfactory.	Unsatisfactory.									
French Brook,	70	43	-	-	-	-	21	-	17	-	-	5	2	-	70	-	7	56	7
Muddy Brook,	42	19	-	-	-	-	19	-	17	-	-	2	1	-	42	-	-	39	3
Gates Brook,	216	155	2	-	-	-	45	2	53	1	-	9	3	-	214	2	4	200	12
Malden Brook,	31	15	-	-	-	-	17	-	20	-	-	1	1	-	31	-	-	32	2
Chaffin Brook,	215	132	3	-	-	-	63	6	86	-	1	5	5	-	208	7	89	116	10
Asnehumskitt Brook,	219	160	3	-	2	9	26	2	45	2	2	9	9	1	204	15	182	18	19
Muscelopauge,	93	40	3	-	-	-	37	-	41	-	1	5	5	1	92	1	7	72	14
South Wachusett Brook,	87	39	1	-	-	-	36	-	41	1	-	8	3	-	86	1	-	76	11
Trout Brook,	34	5	-	-	-	-	23	-	20	-	-	3	2	-	34	-	-	29	5
East Wachusett Brook,	217	87	2	-	-	-	86	3	93	-	-	26	15	1	214	3	-	176	41
Stillwater River,	144	70	-	-	-	-	47	1	63	3	-	14	11	1	141	3	-	119	25
Wachusett,	334 ²	81	-	-	-	-	71	2	58	1	-	4	15	94	331	3	-	315	19
French Hill,	35	26	-	-	-	-	6	-	14	-	-	2	1	-	35	-	-	32	3
Totals,	1,740	872	14	-	2	9	497 ²	16	568	8	4	93	73	98	1,705	35	289	1,280	171

¹ On some premises there are two or more cases.² Including 160 summer dwellings at the Wachusett Ponds.³ Summer dwellings not classified.

Summary of Sanitary Inspections on the Sudbury and Cochituate Watersheds in 1918.

DISTRICT.	Number of Premises in- spected. ¹	CLASSIFICATION OF CASES INSPECTED.											CONDITION AT END OF YEAR.				
		Sewer Connections.	Cesspools dug before 1918.	Cesspools dug during 1918.	Direct Privy Drain- age.	Indirect Privy Drain- age.	Direct Sink Drainage.	INDIRECT SINK DRAINAGE.		BARN DRAINAGE.		Manufacturing Wastes.	Premises Vacant.	No Drainage.	Drainage carried to Filter-beds.	Satisfactory.	Unsatisfactory.
								Satisfactory.	Unsatisfactory.	Satisfactory.	Unsatisfactory.						
SUDBURY WATERSHED.	328	316	6	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	98	—	66	3	—	—	23	—	44	—	—	6	—	—	—	97	1
	302	—	255	4	—	—	22	2	33	—	—	10	6	2	—	298	4
	2,032	1,656	261	5	—	—	83	1	171	—	—	9	16	1,831	2,031	1	1
	337	—	257	3	—	—	60	1	98	—	—	14	2	—	—	336	1
	—	—	213	—	—	—	8	—	26	—	—	3	6	—	—	232	—
	403	—	234	—	—	—	102	6	63	3	—	54	7	—	—	394	9
	183	—	106	—	—	—	45	4	50	1	—	18	9	—	—	178	5
	177	—	58	—	—	—	81	—	35	1	—	36	2	—	—	176	1
	797	550	173	2	—	—	41	3	97	—	—	30 ²	13	—	—	794	3
Totals,	4,889	2,522	1,629	18	—	2	405	17	625	8	1	180	65	1,833	4,864	25	25
COCHITUATE WATERSHED.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	249	—	185	6	—	1	15	1	27	1	—	42	—	—	—	248	1
	1,090	783	249	1	—	—	31	—	66	—	1	15 ⁴	13	1,022	1,090	—	—
	—	—	108	—	—	—	16	—	33	—	—	10	1	—	139	—	—
	1,738	1,352	296	9	—	—	51	2	120	1	—	11	16	1	1,735	3	3
Totals,	3,216 ²	2,137	838	16	—	1	113	3	246	2	1	78	30	1,023	3,212	4	4

¹ On some premises there are two or more cases.

² Including 210 summer dwellings.

³ Fifteen of these premises connected with the public sewer.

⁴ Four of these premises connected with the public sewer.

Sudbury Watershed.

On the Sudbury watershed there were 4,877 premises at the beginning of the year and 4,889 at the end of the year, an increase of 12 premises during the year, resulting from the construction of 13 buildings and the elimination of 1 building. Five of the new premises are connected with public sewers which carry the drainage off the watershed.

Building activities were limited to the completion of houses begun in previous years and to the construction of new factories or additions to existing factories engaged on war contracts.

The drainage from the Deerfoot farm factory and the Fay and St. Mark's schools in Southborough has been satisfactorily cared for by the owners of these properties.

Sixteen cases of typhoid fever were reported from Marlborough during the year, 12 of which were caused by polluted milk supply. In 12 cases the premises are connected with the public sewers which carry the drainage off the watershed, and in the other four cases the premises are provided with cesspools.

Cochituate Watershed.

On the Cochituate watershed there were 3,198 premises at the beginning of the year and 3,216 premises at the end of the year, an increase of 18 premises, which results from the construction of 19 buildings and the elimination of 1 building. Seven of the new premises are connected with the public sewers which carry the drainage off the watershed.

As in the case of the Sudbury watershed, building activities were limited to the completion of houses begun in previous years and to the construction of new factories or additions to existing factories engaged in war contracts.

Many summer cottages on this watershed were not occupied during the year and the building boom near Lake Cochituate was limited to the construction of 5 cottages.

Concrete settling basins are being constructed by the Natick Box Company to prevent the discharge of large quantities of paper pulp which now flows from its premises into an adjoining brook causing a nuisance along its course and at the intercepting reservoir near the Pegan pumping station.

At the beginning of the year the manufacturing industries in Framingham were greatly hampered by the coal shortage, but the twenty largest companies employed about 8,000 hands. During the summer this number was increased to about 10,000, but since the signing of the armistice it has fallen rapidly and not over 4,000 were employed at the end of the year.

During the year 3 cases of typhoid fever were reported from Framingham in houses connected with the public sewers and 1 case was reported from Natick in a house which was connected with a cesspool.

PROTECTION OF THE WATER SUPPLY.

Filtration and Chlorination.

On the Wachusett watershed the surface water from 525 acres in the village of Sterling has been filtered at the Sterling filter-beds. The sewage from the Worcester County Training School has been purified at the filter-beds on Beaman Street in West Boylston. This institution now accommodates 74 boys and teachers. The sewage from five small cottages at Sterling Junction was filtered at the Gates Terrace filter-beds from April 15 to October 30, while the cottages were occupied. The cost of maintaining all of these filter-beds was \$860.93, including an expenditure of \$135.43 for replacing with reinforced concrete the wooden troughs at the Worcester County Training School filters, which had been in use since the filters were constructed in 1903.

On the Sudbury watershed the surface water from an area of two square miles in Marlborough has been filtered at the Marlborough Brook filter-beds before entering the Sudbury Reservoir, with the exception of 70,400,000 gallons on February 15, 16, 19, 21 and 26 and March 1 and 2, which the filters could not take care of and as it overflowed at the wasteways it was treated with calcium hypochlorite with the exception of about 2,400,000 gallons which was not treated because of delay in receiving the calcium hypochlorite. Diluted sewage from the Marlborough main sewer was received at the combined storage reservoir and filter-bed on Farm Road on February 15, 16, 20 and 26 and March 1, April 21 and 22 and September 27. Ground water from the sewer underdrain was filtered at the Farm Road bed during every month except January. The filter-beds received the usual attention; the weeds and grass on the artificial beds were cut and

removed by the one-horse weeder and cultivator and the natural beds were cleaned by removing the surface deposit in the early summer and late in the fall the hardened surface of the beds was harrowed and the large stones which were loosened were removed. Cracks in quite a number of dams at the inlets of distributing channels and in the concrete aprons of the beds were cut out and pointed. Paving at the outlet of bed No. 2 was relaid, a new driveway was built from the street to bed No. 19 and the office and sheds were painted.

The drainage from the Southborough swimming pool was filtered at the bed near Boston Road and the pool and filter-bed were cleaned once during the season. On account of a crack in the vault in the outhouse connected with the pool the outhouse was closed on June 27 and the bathhouse on July 9. On account of difficulty in obtaining labor to make the necessary repairs and of securing watchmen to look after the swimming pool the Selectmen of Southborough stopped the use of the pool July 15.

The surface water from Cherry Street Brook at Fayville was treated with calcium hypochlorite whenever there was any surface wash from the premises which drain into this brook.

The cost of the filtration and chlorination work on the Sudbury watershed was \$2,608.74.

On the Cochituate watershed the surface water from an area of about one square mile of the thickly settled portion of the town of Natick was pumped at the Pegan station and filtered before it entered the lake, with the exception of the overflow from the Pegan receiving reservoir on January 12, February 15, 20 and 26 and March 1, amounting to 4,500,000 gallons, and from the intercepting reservoir except on January 12, February 13 to 16, inclusive, February 19, 20, 26 and 27, March 1, 2, 6, 7, 10 and 13 to 16, inclusive, and April 22, amounting to 28,500,000 gallons, and the overflow at Kansas Street on February 15 and 16, amounting to 3,000,000 gallons. All of this water, which overflowed directly into the lake was treated with calcium hypochlorite except the 3,000,000 gallons at Kansas Street.

The pumping station was operated on 215 days during the year and 271,547,000 gallons of surface water, equivalent to an average of 743,964 gallons per day for the entire year, were pumped to the filters. The cost of operating and maintaining the pumping station and filters

was \$5,664.84 which is equivalent to a cost of \$20.86 per million gallons.

The filter-beds were cleaned and weeded several times in order to keep them in proper condition. The deposits in the brook and ditches, the receiving reservoir and intercepting reservoir and ditch were removed and teamed away. A deposit of paper pulp from the factory of the Natick Box Company, about 18 inches in depth and amounting to 980 cubic yards, was removed from the bottom of the intercepting reservoir by pumping it onto bed No. 6. The cost of this work is paid for by the Natick Box Company which is now installing settling tanks at the factory with a view to keeping this deposit out of the brook.

The force employed at this station during the summer has been larger than usual in order to clean up the grounds around the station and the approach to the station from Washington Avenue so that they will be in satisfactory condition. This work has increased the maintenance expenses at this station somewhat above the expenditures during previous years.

Improvement of Swamps and Brooks.

The ditches maintained in the swamps on the watersheds for improving the quality of the water were cleaned and the weeds and brush were mowed for a width of 10 to 20 feet on both sides where necessary.

This work was done in the Wachusett Department along 23.5 miles of the 27.73 miles of ditches, some of the ditches in remote and unimportant locations being given less attention than usual this year. The cost of the work was \$823.14.

The cost of the usual cleaning and mowing along the 8.94 miles of ditches which are cared for by the Sudbury Department was \$444. The sod and grass were removed from the paving and repairs were made at various places, including 317 linear feet of new board bottom, 336 linear feet of new corner pieces and 150 square yards of paving taken up and relaid, the total cost of the repairs being \$744.28.

The work of improving Gates Brook in the Wachusett watershed at the district known as "The Settlement," which was suspended on September 20, 1917, was not resumed on account of the scarcity of labor and high cost of materials.

For the protection of the water supply 28.75 acres of land located on Main Street in Boylston and 9.67 acres located along Waushacum Brook in Sterling were acquired on the Wachusett watershed during the year, and for the same purpose the fee was acquired in 2.44 acres of land located in Little Crane Swamp in Northborough on the Sudbury watershed, where drainage ditches tributary to the open channel portion of the Wachusett Aqueduct had previously been constructed under an easement acquired in July, 1899.

CLINTON SEWAGE DISPOSAL WORKS.

Chapter 557 of the Acts of the year 1898 provides that works for the disposal of the sewage of the town of Clinton shall be maintained and operated by the Metropolitan Water Works until the sewage of said town shall have outgrown the normal capacity of the South Branch of the Nashua River to properly dispose thereof.

As a result of informing the town officials that in our opinion the time is near at hand, if it has not already been reached, when this provision of the statute should become operative, the town appointed a committee to investigate and report upon the leaky condition of the sewers and any other causes for the excessive quantity of sewage which is now received at the pumping station. This committee employed a civil engineer to make an investigation and report to the annual town meeting which will be held in March, 1919.

In connection with the operation of the works the pumping station was operated daily and the quantity of sewage pumped to the filter-beds was equivalent to 1,065,000 gallons per day throughout the year, which is 15,000 gallons per day more than in 1917 and about equivalent to the average of the past seven years.

The Blake compound duplex pump and the boiler have been kept in reserve for service in case of emergency. All of the sewage was pumped with the electrically driven 12-inch DeLaval centrifugal pump installed in 1912. The pumping statistics are as follows:—

Total pumpage (gallons),	388,679,000
Average pumpage (gallons per day),	1,065,000
Electric energy used (kilowatt hours),	126,220
Pumpage per kilowatt hour (gallons),	3,079
Average lift (feet),	49.7
Efficiency of pumping unit and transmission line (per cent.),	53.4
Coal used for burning sludge and heating (pounds),	58,171

Cost of pumping: —

Labor,	\$1,337 04
Electric energy at \$5.30 per thousand kilowatt hours,	668 97
Coal for burning sludge and heating,	170 61
Repairs and supplies,	333 12

Total for station, \$2,509 74

Cost per million gallons, \$6 46

Cost per million foot gallons, 0 1299

Filters.

The filter-beds and settling basins were operated jointly daily throughout the year by first passing the sewage through one of five settling basins the effluent from which was applied to the 25 one-acre sand filter-beds in regular doses of 59,000 gallons of sewage in 30 minutes, at intervals of about $1\frac{2}{5}$ days, equivalent to about 41,500 gallons per acre per day. The cost of maintaining the filters during 1918 was as follows: —

Labor,	\$4,417 29
Supplies and expenses,	996 32

Total, \$5,413 61

Cost per million gallons, \$13 93

The character of the effluent, as shown in the following table, has continued to be much less satisfactory than in years previous to 1916, due to the condition of the filtering material near the surface of the beds.

[Parts per 100,000.]

	1915.	1916.	1917.	1918.
Albuminoid ammonia, sewage,	1.4350	1.0255	.8652	.8792
Albuminoid ammonia, effluent, . . . . .	.09347	.0983	.1383	.1439
Reduction, per cent.,	93.5	90	84	83.6
Free ammonia, sewage,	3.7867	2.7850	3.4707	3.2300
Free ammonia, effluent, . . . . .	.5924	1.0316	1.7658	1.5094
Reduction, per cent.,	84	63	49	53
Nitrogen as nitrates, effluent, . . . . .	.7152	.3693	.20165	.2866
Iron, effluent, . . . . .	.30815	1.052	2.036	1.903
Average quantity of sewage filtered, gallons per day,	941,000	1,225,000	1,050,000	1,037,000

During September, October and November experiments were made in washing the filtering material on one of the gravel beds for a depth of 6 to 10 inches. This surface material had become thoroughly filled with organic matter and the efficiency of the filter had been greatly reduced. As there was no good filtering material in the vicinity of the beds the cost of removing the dirty gravel and replacing it with new material would have involved much expense and it was therefore decided as a matter of economy to wash the dirty gravel and replace it on the beds. This is a common practice in connection with the operation of water filters but a novelty in connection with the operation of sewage filters.

Bed No. 5 was chosen for the experiment as it was conveniently located for the purpose so that the effluent from the filters could be used for wash water and this bed represented about an average condition of all the gravel beds.

The gravel washing plant consisted of a No. 1 Stocker gravel washer, driven by a belt-connected $2\frac{1}{2}$ -horse power Alamo gasoline engine mounted on a wooden frame and moved about on wooden rollers; a small portable pumping unit consisting of a Swaby centrifugal pump with a capacity of 75 gallons per minute operated by a $1\frac{3}{4}$ -horse power Brownwall gasoline engine. About 450 feet of $2\frac{1}{2}$ -inch fire hose was used between the pump and the washer for conveying the washing water, and wooden troughs were used for disposing of the dirty water from the washer. The cost of this outfit fully equipped and set up ready for operation was \$629.63 for the apparatus and \$124.89 for labor, making the total cost \$754.52.

The Stocker gravel washer consists of a steel cylinder 8 feet long and 30 inches in diameter, to the inside of which are riveted steel angles running lengthwise of the cylinder about 3 inches apart. Hung from an independent frame inside the cylinder are a number of sheet steel chutes the inclination of which may be varied to meet the requirements. The dirty material is fed into the revolving cylinder at one end and conveyed through it by alternately dropping down the chutes and being carried up again to the next one by the angle strips. The clean water enters at the other end of the cylinder and passes slowly through the washer in the opposite direction to the material. In this way the material gets several washings and scourings, each time with cleaner water, until finally the dirty water and material washed out of the gravel is discharged at one end and the clean material at the other end.

The bed is about 200 feet square and has an area of 1.02 acres. For convenience the dirty material was scraped from sections of the bed about 50 feet wide and conveyed to the washer with a one horse drag scoop and then shoveled into the hopper, the washer being moved along the section as the work progressed. The washed gravel was shoveled into piles and later graded into place with the drag scoop after the surface of the bed which had been worked over was loosened with a harrow to break up any stratification that might occur between the washed material and the gravel which had not been disturbed by the operation. The residue from the process which did not pass off with the wash water was hauled away in carts to the dump.

About 1,100 cubic yards of material was washed in this manner with a loss of about 20 per cent. in volume. This represented approximately 75 per cent. of the organic matter and sludge which had caused the sealing of the filters, and a small per cent. of the finer sand grains in the gravel. After the washed material was replaced on the bed the surface was about 0.13 of a foot lower than before operations began.

The force employed included 7 men and 1 horse all the time and 2 men and 1 horse additional when regrading was being done. The cost of this experimental work was \$2,646.40, of which \$754.52 was expended on the plant. Assuming that the plant will be used on at least 20 beds the portion of its cost chargeable to bed No. 5 would be only \$37.73 and the total cost chargeable to this bed would be \$1,929.61, and the cost per cubic yard of material washed is \$1.75. Experience shows that by equipping the washer with an elevator for handling the washed material, a sludge pump and pipe line for removing the dirty water and sludge, and by undertaking the work in a systematic manner the cost should be materially reduced in the future.

Observations made during the month that this bed has been in service since the work was completed indicate that considerable benefit has resulted. The sewage now enters the bed freely when applied in doses of 62,000 gallons in 30 minutes at intervals of about 1.6 days, which is equivalent to a rate of filtration of about 38,000 gallons per acre per day, and dissolved oxygen is again present in the effluent.

FORESTRY.

Wachusett Department.

The 76.3 acre parcel back of the Westerly Portion of the North Dike at the Wachusett Reservoir, which was cleared and planted in 1917 with white pine seedlings spaced 12 feet apart in rows 12 feet apart, has been further developed by interplanting with red pine seedlings 3 years old and white pine seedlings 4 years old, making the trees in the finished planting 6 feet apart in rows spaced 6 feet apart. The remainder of the white pine seedlings raised in the North Dike nursery were used in this work and the nursery was discontinued and included in the planted area. The total number of trees used in this work in 1917 and 1918 is as follows:—

White pine seedlings, 4 years old, planted in 1917,	23,000
Red pine seedlings, 3 years old, planted in 1918,	43,000
White pine seedlings, 4 years old, planted in 1918,.	33,350
	<hr/>
	99,350

About 7,000 of these were used to fill in failures.

Parcels of water works land located along the margins of the Wachusett Reservoir in Sterling, Boylston and West Boylston, aggregating 90 acres, were planted with white pine seedlings 3 and 4 years old and white spruce seedlings 6 years old from the Oakdale nursery. In this work 91,700 white pine, 43,000 red pine and 1,300 white spruce seedlings were used. The cost of preparing the trees in the nurseries and field planting was \$14.41 per thousand. An access road 900 feet in length, 15 feet wide with margins 15 feet on each side, was constructed through one of the lots.

Sixty acres of water works land bordering on the Wachusett Reservoir and tributary streams, which had been recently burned over or was grown to chestnut trees seriously damaged by the chestnut bark disease, or was badly infested with the gypsy moth, were cleared for planting with white pines. This work cost \$2,820 or about \$47 per acre, and cord wood and fence posts having a value of \$1,190 were obtained.

A quantity of white pine seed collected and stored during 1917 was planted in seed beds in the Oakdale nursery last spring and 134,000 white and red pine seedlings 1 year old furnished by the

State Forester's department from the nursery at Amherst were set out in transplant beds, but on account of their condition when received, and the unfavorable weather which immediately followed the transplanting, about 60 per cent. of them died.

Many of the Scotch pine seedlings in the Oakdale nursery were attacked with the blister rust and upon the advice of the Nursery Inspection Department of the Commonwealth were destroyed. It is probable that the entire lot now on hand will also have to be destroyed as the sweet fern, which is the alternate host necessary for the spread of this disease, is very prevalent on the water works land.

The necessary care has been given to the trees in the Oakdale nursery, which at the end of the year contained the following:—

White pine seedlings, 1 year old, in seed beds,	191,000
White pine seedlings, 2 years old, in transplant beds,	51,000
White pine seedlings, 3 years old, in transplant beds,	6,900
White pine seedlings, 4 years old, in transplant beds,	44,000
White pine seedlings, 5 years old, in transplant beds,	13,000
Scotch pine seedlings, 4 years old, in transplant beds,	38,000
Red pine seedlings, 2 years old, in transplant beds,	3,400
Red pine seedlings, 6 years old, in transplant beds,	100
Norway pine seedlings, 4 years old, in transplant beds,	200
White spruce seedlings, 7 years old, in transplant beds,	10,000
Tamarack seedlings, 3 years old, in transplant beds,	5,800
Sequoia seedlings, 7 years old, in transplant beds,	100
Maple seedlings, 2 years old, transplanted from field,	750
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	364,250

The sprouts and undergrowth which were interfering with the pines on about 177 acres of land planted during the past few years were cut and disposed of at a cost of about \$14 per acre. Where these plantings were along main highways the brush was removed and burned for a width of 100 feet from the roadside; at other points it was left to die and rot on the ground.

Improvement thinning was made on 14 acres of timber land on the margin of the Wachusett Reservoir in Clinton and West Boylston at a cost of \$577.37, and cordwood which was sold for \$385 was obtained from this work.

The improvement thinning begun in 1916 of a portion of Big Crane Swamp in Westborough, which was thickly grown with cedars,

was continued in the early spring and 1,310 first class fence posts obtained from this work were used in connection with fence repairs and 400 first class fence posts were stored for future use. At the close of the year this work has been resumed and fence posts and saw logs for the manufacture of shingles are being obtained.

The trees and shrubbery at the Wachusett Dam and the trees on water works land adjacent to the main highways about the Wachusett Reservoir and Waushacum Ponds, the Sterling and Clinton sewerage filter-beds, which were infested with gypsy moths were sprayed with 4,500 pounds of arsenate of lead during May and June at a cost of \$1,104.88.

During the past few years considerable time and money have been spent in an attempt to check the spread of the gypsy moth by scouting for and painting with creosote the egg clusters, but it does not appear practical to thoroughly prosecute this work in the large wooded areas around the Wachusett Reservoir, and, as the abutting woodland is not similarly treated by the private owners and the United States Government has planted gypsy moth parasites in this territory, our attempt to check the spread of the gypsy moth during the past year has been confined almost entirely to spraying. There were, however, 4,500 gypsy moth egg clusters found and painted with creosote on the trees and shrubbery at the Wachusett Dam at a cost of \$89.88.

During June and July many of the white pine plantings on the marginal lands around the reservoir were inspected for the pine-tree weevil on two occasions, at a cost of \$152.18. During the first inspection 7,300 leaders were cut and burned and 450 during the second inspection. The work was confined to the areas having trees of medium height and under, as larger trees are less affected, the work more difficult and the expense is hardly warranted.

The total cost of protecting the trees and plantings from insects and disease during the year was \$1,346.94.

The usual fire patrol service was maintained during the spring and fall. Three forest fires, involving considerable damage to the white pine trees, occurred during March and April when the conditions were particularly favorable. On March 24 sparks from a locomotive on the Boston & Maine Railroad started a fire among the young pines on the lot in Oakdale between Pleasant Street and the Stillwater River. About 11 acres were burned over and approximately

13,000 trees destroyed. The Railroad Company reimbursed the Commonwealth for the loss which amounted to \$265.50. On April 7 trespassers near the North Dike started what would undoubtedly have been a very serious fire but for the prompt action of our patrolman, who, with the assistance of some neighbors, put out the fire with a loss of about 28 pine trees from 6 to 15 feet high and 80 pine trees about 2 feet high. In this case the offenders were summoned into court and heavy fines imposed. On April 15 about 11 acres of land on the margins of the reservoir in Sterling, planted to white pines from 2 to 4 feet high, were burned over destroying about 13,000 trees. This fire started from the operations of the department employees who were burning brush in this vicinity.

The brush, grass and weeds on $1\frac{3}{4}$ miles of marginal fire guard, which is 40 feet wide, and on $1\frac{1}{4}$ miles of forest roads from 15 to 45 feet wide, were mowed and burned at a cost of \$153.28.

At the close of the year the water works lands in the Wachusett watershed may be classified as follows: —

Forest lands acquired and not since improved (acres),	1,357
Forest lands acquired and since improved (acres),	330
Land which has been planted with trees and not cleared (acres),	238
Land which has been planted with trees and since cleared (acres),	1,283
Land to be planted with trees (acres),	588
Open land which will probably not be planted (acres),	820
Marginal strip along shore of the reservoir (acres),	212
Total,	4,828

The total expenditures for forestry during the year in the Wachusett Department were \$14,860.

Sudbury Department.

In May 150,000 white pine seedlings 2 years old and 50,000 4 years old were received from the State nursery at Amherst, of which 125,000 2 years old and 10,000 4 years old were set out in the nursery at the Sudbury Reservoir.

White pine seedlings from this nursery were planted as follows: 40,800 seedlings 3 years old at the Sudbury Reservoir east of Acre Bridge, on land cleared back of the Bigelow place on Farm Road and at several other places; 1,900 seedlings 4 years old at Whitehall Reservoir; and 13,100 seedlings 4 years old at Framingham Reservoir No. 3.

Along the Weston Aqueduct white pine seedlings 4 years old were set out as follows: 1,400 east and west of Edgell Street; 1,400 at the White place; 1,750 east of gaging chamber No. 2; 800 west of Elm Street; 1,000 west of Pine Ridge Street, and 600 at the west portal of Tunnel No. 4.

Along the Sudbury Aqueduct 8,500 seedlings were field planted on the slopes of the cut easterly of the first crossing of Wellesley Avenue and 3,000 were field planted on the stretch of land on the southerly side of the Cochituate Aqueduct east of Morse's Pond.

At Lake Cochituate a small nursery was established near the woods opposite the foreman's house on West Pond Street, and 25,000 seedlings 2 years old and 6,550 4 years old were set out for future use.

There are now on hand at the nursery at Sudbury Reservoir 125,000 white pine seedlings 2 years old and 10,000 4 years old.

Part of the trees at the Sudbury Reservoir, Framingham Reservoirs Nos. 1, 2 and 3, Lake Cochituate and at the White place and near siphon chamber No. 2 on the Weston Aqueduct were sprayed with arsenate of lead in May and June. The power sprayer was in use 24 days with an average force of 9 men on this work and 8,000 pounds of arsenate of lead were used. The total cost of the work was \$2,044.53.

Brown-tail moth caterpillars were destroyed within 50 feet of the highways at the Sudbury and Framingham reservoirs and incidentally at other places in connection with spraying work.

Gypsy moth egg masses were painted with creosote as follows: 43,400 at the Sudbury Reservoir, 8,300 at the Framingham reservoirs, 35,600 along the Cochituate Aqueduct, 10,600 along the Sudbury Aqueduct and 55,000 along the Weston Aqueduct, at a cost of \$539.60.

The pine trees at Sudbury, Ashland and Hopkinton reservoirs and along the Weston Aqueduct were inspected for the pine-tree weevil and 14,600 leaders were cut off and destroyed at a cost of \$338.21.

At the Sudbury Reservoir 11,300 feet of new fire guard 40 feet in width and 6,400 linear feet of forest lanes 40 feet in width were cut and the brush was mowed on 12,740 feet of old fire guard and 3,127 linear feet of old forest lanes. The cutting of fire guard and forest lanes is now practically finished at this reservoir. The total length is 4.55 miles of fire guard and 1.81 miles of forest lanes.

The wood on about 15 acres of land east of Acre Bridge, Marlborough, and in the rear of the Bigelow place on Farm Road was sold to various parties who also cut and burned the brush and limbs. About 8 acres of land were cleared by the department force on Pine Hill; the wood was sold and the brush burned. An improvement thinning was also made among the deciduous trees on the hill and 1,300 chestnut posts were obtained where chestnut trees affected with the bark disease were cut down. Grass and brush between the field planted pines and the highways were cut and burned and the lower limbs of many pine trees which were dragging on or very near the ground were cut off to protect them from fire. On Robinson and Nichols hills on the southerly side of Sudbury Reservoir the brush was cut where it was interfering with the growth of the field planted pines.

At Framingham Reservoir No. 3 scrub oaks infested with the gypsy moth were cut on the west shore of the reservoir for a distance of about 1,800 feet northerly from the New York, New Haven & Hartford Railroad, and all the wood was cut on the two islands in the reservoir. All of the wood that was of any value was used for fuel at the gate-houses and the brush and limbs were burned on the ground.

All of the trees for a distance of about 300 feet along the Cochituate Aqueduct west of Oak Street in Natick, except the pines and some large maple trees, were cut and the wood was hauled to the gate-house at the lake and used for fuel.

During the year there were two forest fires at Sudbury Reservoir, burning over an area of about 0.4 of an acre and destroying 200 trees; three at Framingham Reservoir No. 3, burning over an area of about 4 acres and destroying 3,500 trees; two at Framingham Reservoir No. 2, in which no trees were burned but 120 feet of old fence destroyed; one at Lake Cochituate burning over a small area on the west shore but causing no damage; one on the Cochituate Aqueduct on the westerly side of Walnut Street in Newton, in which 200 transplanted pines 5 inches to 12 inches in height and 20 pines 2 feet in height were destroyed; one on the south side of the Cochituate Aqueduct burned over an area of about 1 acre and destroyed 1,000 transplanted pines 8 inches high, and one on the Weston Aqueduct at the entrance to tunnel No. 4 in which 400 white pines 5 years old averaging 15 feet in height were burned.

Several of the fires were of unknown origin, five were caused by sparks from locomotives on the adjoining railroads and two by the carelessness of adjoining owners. There has been received in settlement from the railroad companies and adjoining owners for the damage done \$738.81.

The total amount expended for forestry in the Sudbury Department during the year was \$8,287.89.

Distribution Reservoirs.

Gypsy and brown-tail moths and elm-leaf beetles were destroyed on water works lands around the distributing reservoirs as in former years by spraying the foliage with arsenate of lead during the crawling season, by painting the gypsy moth egg clusters with creosote and burning the brown-tail moth webs during the winter.

The two-horse Fitzhenry-Guptill power sprayer was used for the spraying and 4,410 pounds of arsenate of lead in paste form were used.

Oyster scale, found on shrubs at Chestnut Hill Reservoir, was destroyed by using Scalecide and Arlington oil. The leaders on pine trees at the Weston Reservoir, which were infested with the pine-tree weevil, were cut off and burned.

Four fires occurred in the woods at Spot Pond during the year which burned over a total area of about 10 acres and destroyed 225 pines and 60 oak trees.

The total expenditures for forestry at the distribution reservoirs were \$2,449.36.

HYDRO-ELECTRIC SERVICE.

The total quantity of electric energy delivered during the year from the two hydro-electric stations which are operated in connection with the Metropolitan Water Works was 14,109,355 kilowatt hours.

The total value of this energy at the contract prices is \$80,270.64. The total expenses chargeable to both stations are \$40,236.04, leaving a profit for the operation of the stations of \$40,034.60, equivalent to \$2.837 per thousand kilowatt hours.

Wachusett Power Station.

The Wachusett power station was operated on 298 days during the year. The energy not used in connection with the operation of the Metropolitan Water Works was sold to the New England Power

Company under an agreement made September 30, 1916, which provides that until the completion of the Wachusett-Sudbury transmission line the company will take as much energy from the Wachusett power station as it can reasonably and properly use without wasting water at its own plants. Under this arrangement 100 per cent. of the water drawn from the reservoir into the Wachusett Aqueduct was used to develop electric energy. The station has now been in operation $7\frac{1}{2}$ years and this is the first year that all of the water drawn from the reservoir for water supply purposes has been used to generate electric energy.

An examination and test of the station equipment to determine what changes, if any, were necessary to ensure the safety of the operators and the equipment and to conform to the best modern practice, was made by experts from the laboratory of the Edison Electric Illuminating Company of Boston in January. Alterations of a minor character only were found to be necessary. A number of these changes have been made and the others will be completed as soon as the necessary materials are received. The principal change thus far made has been to substitute rigidly fixed bevel gears and connecting shafts in place of the sprocket wheels and chains which were formerly used for the operation of the machine rheostats, so as to remove the possibility of a broken chain falling across the bus bars. Asbestos wood barriers have been prepared to place at high voltage fuses and switches where damage might result from arcing.

Plans were made and the apparatus installed for utilizing so far as possible for the generation of energy the water which has to be wasted from the Wachusett Reservoir at times of extreme high water. This waste water could not formerly be used to generate electricity. The new apparatus consists of two large wooden electrically-operated sluice-gates installed at the entrance to the aqueduct, so arranged that all or any part of the water passing through the water wheels can be turned either into the aqueduct for water supply purposes or wasted through the pool into the Nashua River. In connection with this arrangement it has been necessary to increase the capacity of some of the transformers and meters used in measuring the electric energy and to rearrange the sanitary and other fixtures in the locker room.

The wooden head-gates are each 15 feet 6 inches long x 6 feet 5 inches wide, made up of 18 pieces of long leaf yellow pine plank each $9\frac{3}{4}$ inches wide and varying in thickness from $5\frac{3}{4}$ inches at the

bottom to $3\frac{3}{4}$ inches at the top. These planks are held together by means of two through rods 1 inch in diameter and two angle irons 6 inches x $3\frac{1}{2}$ inches x $\frac{1}{2}$ inch bolted to the ends. The joints in the planking and between the iron and wood work were made water tight by the use of splines, cotton wicking and asphaltum varnish. To the bottom of each gate there is attached a steel forged connection to which the lower end of a steel screw stem $2\frac{3}{4}$ inches in diameter is fastened. This stem operates in a gate stand set on the floor of the room above the entrance to the aqueduct and is driven by a $4\frac{1}{2}$ -horse power electric motor through a train of gears arranged to operate the gate at a speed of about 1 foot per minute. The gates travel vertically $13\frac{1}{2}$ feet in iron grooves placed in the concrete walls at the entrance to the aqueduct, and the water when passing into the aqueduct flows beneath the gate which may be set at any desired elevation.

When operating the station and wasting water through the pool the elevation of the tail water in the well beneath the generating room will be nearly up to the underside of the floor and it became necessary to equip the Lombard governors with an automatic device for controlling the wicket gate openings on the water wheels within fixed limits. The operator in charge of the station originated and perfected an ingenious electrical device by which the gate is blocked at any desired opening under normal operation and is immediately brought under the free control of the hydraulic governor by the tripping of the circuit breaker in case of an interruption in service. Unit No. 2 has been operated with this device since last July, during which time it has been perfected, and the other units are now being equipped with the device.

To localize trouble and prevent the interruption of service on the New England Power Company's lines the Company, on September 14, installed reverse power relays at the station to operate in connection with two oil switches controlling the two cables through which energy is supplied to the Company, in addition to the relays which were provided by this department for the protection of our apparatus when it was installed. It is necessary to keep both underground cables in service all the time with this arrangement, but if both cables should break down simultaneously at any time the Company has agreed to install a temporary overhead line and make good any loss of revenue resulting from such failure of the cables.

The lightning arresters have been equipped with charging resistances and meters for determining the condition of the electrolyte so that they can be kept in proper condition at all times.

During an electrical storm on June 14 two series transformers on the station service lines were burned out and the station was idle for about six hours while temporary repairs were being made. New transformers, costing \$146.31, have been installed. This was the only interruption of any importance which occurred during the year.

The Wachusett power station statistics for the year 1918 are as follows: —

Total energy developed (kilowatt hours),	8,343,450
Energy used at power station (kilowatt hours),	14,159
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Available energy (kilowatt hours),	8,329,291
Water used (gallons),	39,663,500,000
Average head (feet),	91.4
Energy developed per million foot gallons (kilowatt hours),	2.30
Efficiency of station (per cent.),	73.24

Credits: —

Energy sold New England Power Company, 8,203,071 kilowatt hours at \$0.0053,	\$43,476 28
Energy furnished Clinton sewerage pumping station, 126,220 kilowatt hours at \$0.0053,	668 97
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	\$44,145 25

Charges: —

Superintendence,	\$1,037 91
Labor, operating station,	6,325 38
Repairs and supplies,	2,082 14
Alterations and additions: —	
Labor,	\$478 47
Apparatus and supplies,	1,493 06
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	1,971 53
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	\$11,416 96
Taxes,	2,775 00
Administration, general supervision, interest and sinking fund,	6,330 53
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	20,522 49
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Profit,	\$23,622 76
Cost of available energy per thousand kilowatt hours,	\$2.464

Sudbury Power Station.

The Sudbury power station is usually operated 16 hours every day except Sundays and holidays, but was shut down this year on August 26 in connection with the work of painting the turbines and gate shafts, and on account of the large consumption of water during extreme cold weather was operated on Sunday January 6, on every Sunday from February 3 to March 31, inclusive, and on the holiday February 22 to furnish the amount of water required for supplying the District. The station was also operated on holidays April 19 and November 12 as it was desirable to draw water from the Sudbury Reservoir on those days for water supply.

The regular operating hours were from 7 A.M. to 11 P.M. until April 29 and since then the station has been started up at 6.45 A.M. and shut down at 10.45 P.M. so that the operators' working time on the second shift would conform to the street railway schedules.

The station was operated on 315 days during the year and all the water drawn from the Sudbury Reservoir was used for the generation of electric energy, as none was by-passed around the turbines or wasted at the overflow.

On account of the storage available on both services it has been possible to operate the machinery at maximum efficiency most of the time, which accounts for the very high over all efficiency of the station for the year.

On August 21 the work of connecting the power station with the Wachusett-Sudbury transmission line was begun. Another automatic oil switch was installed at the power station and connected with the spare underground cable. Disconnecting switches were also installed on this line at the power station and at the lightning arrester chamber where connection is to be made later with the low-tension side of a 1,500-kilowatt, 66,000 to 13,200-volt transformer which is to be installed by the Edison Electric Illuminating Company just outside of the chamber. Disconnecting switches were also installed on the lines to both of the 750-kilowatt transformers in the power station so that either transformer can now be readily disconnected in case of trouble.

About midnight December 10 the watchman at the station thought there was indication of a fire at transformer No. 1 and opened the emergency drain valve which allowed the oil to flow out quickly

into the underground storage tank, which is buried in the ground outside of the station for use in case of fire. It was later discovered that there was no trouble with the transformer and the oil was filtered and pumped back after it had satisfactorily passed the required break-down tests. This experience showed that the safety devices work satisfactorily and that for use in the future it would be desirable to have a permanent suction pipe extending from the outside storage tank into the station and a $\frac{3}{4}$ -inch pipe has therefore been installed.

The turbines and gate shafts which had begun to show some evidence of rust were scraped and painted with red lead and litharge mixed in linseed oil. This work was done August 25 and 26 and September 1 and 2.

Sparham cement was applied to the concrete roof and stone coping of the lightning arrester chamber to stop a slight leakage which occurred at times.

During a severe electrical storm on July 17 the automatic oil switch on the Hopkinton line was put out of service by the breaking of one of the porcelain insulators, but the damage was promptly repaired, the station being out of service only $6\frac{1}{2}$ hours.

The portion of the 2-inch wrought iron force pipe from the tight cesspool at the station to the leaching cesspool, which could not be laid at satisfactory depth below the surface of the ground, to prevent freezing, was insulated with pitch and ground cork for a distance of 46 feet where it crosses the bridge over the open channel and with slacked lime for an additional distance of 382 feet. A 2-inch service pipe 130 feet in length was laid from the easterly 60-inch supply main to the tight cesspool to furnish water for flushing purposes.

The Sudbury power station statistics are as follows:—

Total energy developed (kilowatt hours),	5,794,230
Energy used at power station (kilowatt hours),	14,166
Available energy (kilowatt hours),	5,780,064
Framingham Reservoir No. 3 service:—	
Water used (gallons),	25,978,700,000
Average head (feet),	65.21
Weston Aqueduct service:—	
Water used (gallons),	18,436,700,000
Average head (feet),	38.54
Energy developed per million foot gallons (kilowatt hours),	2.41
Efficiency of station (per cent.),	76.80

Credit:—

Energy sold Edison Electric Illuminating Company of Boston, 5,780,064 kilowatt hours at \$0.00625,	\$36,125 39
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Charges:—

Superintendence,	\$1,324 55
Labor, operating station,	7,490 49
Repairs and supplies,	671 03

Alterations and additions:—

Labor,	\$1,839 45
Apparatus and supplies,	1,720 71
	<hr/>
	3,560 16

\$13,046 23

Taxes,	1,010 60
Administration, general supervision, interest and sinking fund,	5,656 72
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19,713 55

Profit,	\$16,411 84
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Cost of available energy per thousand kilowatt hours,	\$3.411
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DISTRIBUTION PUMPING SERVICE.

The greatest demand so far made on the distribution pumping service occurred during the year as a result of the coldest weather experienced since the works were put into service, which caused an unprecedented use of water at a time when there was great difficulty in obtaining fuel and workmen necessary for operating the works. The maximum daily pumpage at all of the stations was 152,376,600 gallons on February 5 as compared with a previous daily maximum of 142,887,200 gallons pumped in 1903. At that time the entire supply was furnished by pumping while a portion of the supply is now furnished by gravity.

The total quantity of water pumped at the five distribution pumping stations during the year was 33,194,370,000 gallons, which is 9,586,350,000 gallons or 40.61 per cent. more than the quantity pumped in 1917. Of the total quantity of water supplied in 1918 67.86 per cent. was pumped before using and 2.22 per cent. was pumped in order to deliver it at the desired elevation.

The total cost of operating all of the pumping stations for the year 1918 was \$186,682.56, which is \$54,351.53 more than for the previous year. This increase includes \$7,875.81 for labor, \$40,152.05

for fuel, \$4,893.91 for repairs, \$543.38 for oil, waste and packing, and \$886.38 for small supplies.

On account of transportation difficulties contractors who had agreed to furnish coal for the pumping stations were unable to do so during the winter and it became necessary to obtain about 1,870 gross tons of semi-bituminous coal through the New England Fuel Administration to keep the pumping stations in operation. Most of this coal was shipped to Boston by water and cost about \$10.90 per gross ton or \$3.75 more than the all rail coal which our contractor was unable to furnish. During the summer the Fuel Administration furnished about 1,020 gross tons of semi-bituminous coal for reserve storage. Most of this was all rail coal, costing about \$7.50 per gross ton in temporary storage bin at the Chestnut Hill pipe yard, and there was an additional expense of about 50 cents per gross ton for transferring it to the pumping station bins as required for use.

Investigations made early in the year showed that we would be unable to contract for a year's supply of coal in the usual manner. After the termination of our 1917 contracts, however, we were able to place orders for 500 gross tons of semi-bituminous coal per month on the basis of the United States Fuel Administrator's price at the mine, plus 17 cents per ton for dealers' commission, and for 3,000 gross tons of anthracite mine screenings on the basis of \$2.25 at the mines. Both orders were placed subject to the dealers' ability to deliver the coal. Small quantities of anthracite screenings were also purchased from local coal yards.

The amount and price of the coal received at the pumping stations during 1918 is as follows:—

DEALER AND KIND OF COAL.	STATIONS (AMOUNT IN GROSS TONS).					Cost per Gross Ton in Bins. ¹
	Chestnut Hill No. 1. ¹	Chestnut Hill No. 2. ²	Spot Pond. ³	Arlington. ²	Hyde Park. ²	
<i>Bituminous.</i>						
E. Russell Norton,	360.15	-	-	-	-	\$7 12
Shaftsbury Coal & Coke Co.,	398.97	-	-	-	-	7 18
*New England Fuel Administration,	432.46	-	-	-	-	11 25
*New England Fuel Administration,	196.16	-	-	-	-	7 07
E. Russell Norton,	-	2,468.43	-	-	-	7 36
Shaftsbury Coal & Coke Co.,	-	1,223.08	-	-	-	7 12
*New England Fuel Administration,	-	903.80	-	-	-	10 85
*New England Fuel Administration,	-	1,180.15	-	-	-	7 00
E. Russell Norton,	-	-	\$15.75	-	-	8 46
*New England Fuel Administration,	-	-	103.61	-	-	11 00
E. Russell Norton,	-	-	-	206.34	-	7 28
Shaftsbury Coal & Coke Co.,	-	-	-	174.37	-	7 17
*New England Fuel Administration,	-	-	-	28.53	-	9 85
Peirce & Winn,	-	-	-	2.50 ⁵	-	10 36
E. Russell Norton,	-	-	-	-	141.34	7 05
*New England Fuel Administration,	-	-	-	-	41.74	9 17
City Fuel Co.,	-	-	-	-	2.19 ⁵	11 48
Totals,	1,387.74	5,775.46	919.36	411.74	185.27	-
Average cost: —						
In bins,	\$8 42	\$7 79	\$8 75	\$7 43	\$7 58	-
On cars,	8 02	7 43	-	7 12	7 37	-
<i>Anthracite Screenings.</i>						
Dexter & Carpenter, Inc.,	691.25	-	-	-	-	\$4 94
Dexter & Carpenter, Inc.,	-	3,324.28	-	-	-	4 79
Staples & Bell & New England Fuel & Supply Co.,	-	487.19	-	-	-	5 03
Metropolitan Coal Co.,	-	37.32	-	-	-	5 18
Locke Coal Co.,	-	-	518.97 ⁵	-	-	5 84
Dexter & Carpenter, Inc.,	-	-	312.14	-	-	6 25
Dexter & Carpenter, Inc., & Staples & Bell,	-	-	-	434.72	-	4 93
Peirce & Winn,	-	-	-	7.16 ⁵	-	5 60
Dexter & Carpenter, Inc., & Staples & Bell,	-	-	-	-	160.90	5 04
Wm. H. Harlow & Sons, and Roxbury Coal Co.,	-	-	-	-	95.02 ⁵	5 76
Totals,	691.25	3,848.79	831.11	441.88	255.92	-
Average cost: —						
In bins,	\$4 94	\$4 82	\$5 99	\$4 94	\$5 31	-
On cars,	4 53	4 48	-	4 75	-	-

* Furnished by various dealers as directed.

¹ Hoisted from cars and wheeled to bins.

² 7,836.74 gross tons of coal were dumped from cars into bins, 1,787.51 gross tons were unloaded in storage pile, of which amount 200 gross tons had been transported 300 feet and put into bins at the end of the year.

³ Unloaded at freight yard, teamed 1½ miles, and dumped into bins.

⁴ Includes cost of unloading coal from cars and all expenses incidental to the storage of the coal except as otherwise noted.

⁵ Delivered at station by truck.

At the end of the year there were 1,534 gross tons of semi-bituminous coal and 1,486 gross tons of anthracite screenings in storage at the pumping stations.

During the past three years the price of Pennsylvania semi-bituminous coal delivered by rail has increased about 75 per cent., from \$3.95 to \$6.95 per gross ton on cars at the Chestnut Hill station, and

of this \$3.00 increase about \$0.70 is on account of the increase in freight rates. In the same period the price of anthracite screenings has also increased in about the same proportion, from \$2.85 to \$5.00 per gross ton, and of the \$2.15 increase about \$0.75 is on account of the increase in freight rates.

Although coal has not been purchased under specifications since the 1917 contracts expired, the coal received has been sampled and analyzed and the results for 1918 are as follows:—

KIND OF COAL.	Number of Samples tested.	British Thermal Units.	Percent-age of Volatile Matter.	Percent-age of Ash.	Percent-age of Moisture.	Percent-age of Fixed Carbon.
Davenport,	51	14,502	19.14	8.39	2.65	72.47
Ake Mine,	27	13,807	23.92	11.93	4.11	64.15
Miscellaneous,	27	14,008	22.56	10.51	3.69	66.93
Anthracite screenings,	65	12,200	8.62	17.16	8.95	74.22

Chestnut Hill Pumping Stations.

At Chestnut Hill pumping station No. 1 the beam on the left hand side of engine No. 1 broke while the engine was in operation on June 24, and repairs were made by using a spare casting which we had on hand and by straightening the connecting rod which was bent when the accident occurred. Later in the year, on September 8, the left hand main crank on this engine cracked and a new forging is now being made at the Atlantic Works. On October 24 the right hand high-pressure piston of engine No. 2 became loose but repairs were completed within a few days. Extensive repairs have been made on boiler No. 4; slight cracks at the edges of the steel sheets where exposed in the furnace have been electrowelded and the brickwork of the furnace has been repaired. Considerable work has also been done in repairing the electric light circuits at this station.

At Chestnut Hill pumping station No. 2 considerable work has been done on the boilers and on the electric light circuits. The electric light plant at this station, which is usually operated for lighting both stations, broke down October 22. Extensive repairs were found to be necessary to put it in satisfactory condition. This work was completed November 22. Both stations were lighted from

the electric light plant at station No. 1 while this work was in progress. On account of the reduced force the heater which was purchased for station No. 2 in 1917 was not installed.

Since September 3 the screenings and bituminous coal burned at station No. 2 have been mixed in the desired proportions as deposited in the bins and better results have been obtained than formerly when the mixing was done as the coal was fired.

At these stations 15,695,300,000 gallons of water were pumped to supply the southern high-service district and the southern extra high-service pumping station. For this service the maximum daily pumpage was 62,532,000 gallons on February 5, and the average daily pumpage was 43,000,800 gallons.

From January 1 to February 6 and from April 6 to the end of the year the entire low-service pumpage was for the southern low-service district. During these periods the entire northern low-service supply, a small portion of the southern low-service supply and the supply for the northern high and northern extra high-service pumping stations were furnished by gravity from the Weston Aqueduct supply mains. From February 6 to April 6 the northern low-service district and the northern high and northern extra high-service pumping stations were supplied by the low-service pumps and the southern low-service supply was furnished by gravity from the Weston Aqueduct supply mains.

On account of the fuel and labor situation it was necessary to operate the boilers in battery most of the time. The cost of operating the individual engines was not determined.

The pumping statistics for 1918 are as follows:—

Station No. 1.

	Engines Nos. 1 and 2.	Engine No. 3.	Engine No. 4.	Totals.
Daily pumping capacity (gallons),	16,000,000	20,000,000	30,000,000	66,000,000
Total quantity pumped (million gallons), . . .	1,538.29	-	284.80	1,823.09
Daily average quantity pumped (gallons), . . .	4,214,500	-	780,300	4,994,800
Bituminous coal used (pounds),	-	-	-	2,793,007
Anthracite screenings used (pounds),	-	-	-	1,501,750
Average lift (feet),	132.94	-	124.05	131.55
Cost of pumping: —				
Labor,	-	-	-	\$12,008.61 ¹
Fuel,	-	-	-	14,305.90
Repairs,	-	-	-	4,402.86
Oil, waste and packing,	-	-	-	265.12
Small supplies,	-	-	-	525.45
Totals,	-	-	-	\$31,507.94
Cost per million gallons pumped,	-	-	-	\$17.2827
Cost per million foot gallons,	-	-	-	.1314

¹ Operation and care of station with machinery held in reserve a large portion of the time.

Station No. 2.

	Engines Nos. 5, 6 and 7.	Engine No. 12.	Totals.
Daily pumping capacity (gallons),	105,000,000	40,000,000	145,000,000
Total quantity pumped (million gallons),	13,351.75	13,872.21	27,223.96
Daily average quantity pumped (gallons),	36,580,100	38,006,100	74,586,200
Bituminous coal used (pounds),	-	-	9,756,064
Anthracite screenings used (pounds),	-	-	7,737,469
Average lift (feet),	36.26	122.44	80.17
Cost of pumping: —			
Labor,	-	-	\$35,727.67
Fuel,	-	-	54,936.41
Repairs,	-	-	6,978.30
Oil, waste and packing,	-	-	904.75
Small supplies,	-	-	965.79
Total,	-	-	\$99,512.92
Cost per million gallons pumped,	-	-	\$3.6553
Cost per million foot gallons,	-	-	.0456

On account of the limited capacity of the southern high-service reservoirs and of the use of the Weston Aqueduct supply mains for furnishing considerable water to the low-service districts without pumping, considerable high-service pumping capacity at station No. 1 and low-service pumping capacity at station No. 2 is held in reserve for emergency service; the stations are not usually operated at full capacity and the efficiency of the machinery is reduced somewhat under these conditions.

The electric light service for both stations was furnished from station No. 1 from October 22 to November 22 and from station No. 2 during the remainder of the year.

Spot Pond Pumping Station.

The installation of a steam jet ash conveyor and of an 18-inch Pelton water wheel and $2\frac{1}{2}$ -kilowatt generator for electric lighting service when the steam plant is not in operation, which was begun in 1917, has been completed, and this equipment has given satisfactory service. In connection with the installation of the steam jet ash conveyor a second-hand steel tank with hopper bottom, 6 feet in diameter and 10 feet long over all, was erected on a steel framework, lined with cement mortar and used for the storage of ashes. The tank was arranged so that trucks and teams could be backed under the hopper and loaded quickly and the ashes were removed in this manner from time to time as required.

A Venturi meter installed on the boiler feed line early in the year in connection with the reserve Blake & Knowles simplex $6\frac{1}{2}$ -inch x $4\frac{1}{8}$ -inch x 8-inch boiler feed pump, which was installed late in 1917, remedies an unsatisfactory condition which formerly existed.

All of the water supplied to the northern high-service district during 1918 was pumped at this station, also an emergency supply of 2,511,000 gallons between January 24 and 29 and of 433,000 gallons on November 23 and 24, which was furnished to the town of Marblehead by the town of Swampscott while breaks in the force main of the Marblehead Water Works were being repaired.

The northern high-service pumping statistics for 1918 are as follows: —

Total quantity pumped (gallons),	. . . . .	3,474,700,000
Daily average quantity pumped (gallons),	. . . . .	9,520,000
Bituminous coal used (pounds),	. . . . .	1,951,518

Anthracite screenings used (pounds),	1,995,279
Average lift (feet),	131.82
Engine No. 8 operated (hours),	331
Engine No. 9 operated (hours),	3,973
Quantity pumped by Engine No. 8 (gallons),	142,540,000
Quantity pumped by Engine No. 9 (gallons),	3,332,160,000

Cost of pumping:—

Labor,	\$11,977 86
Fuel,	13,890 64
Repairs,	4,770 48
Oil, waste and packing,	530 80
Small supplies,	440 26

Total for station, \$31,610 04

Cost per million gallons pumped,	\$9.0972
Cost per million foot gallons, . . . . .	.0690

The pumps at this station are operated about 12 hours per day, the boilers being maintained with banked fires at other times, and the machinery cannot be operated at maximum efficiency under these conditions.

Arlington Pumping Station.

All of the water supplied to the northern high-service district during the year was pumped at the Arlington station from the northern low-service mains. The new steam turbine-driven centrifugal pumping unit, which was installed mainly for a reserve and for use at times of unusually large consumption, was put into service on April 8, and the new boiler was put into service on November 19. With these improvements the possibility of an interruption in the service at this station is extremely remote. The electric light plant was overhauled and repaired.

The northern extra high-service pumping statistics for 1918 are as follows:—

Total quantity pumped (gallons),	376,620,000
Daily average quantity pumped (gallons),	1,031,800
Bituminous coal used (pounds),	884,414
Anthracite screenings used (pounds),	814,055
Average lift (feet),	282.32
Engine No. 10 operated (hours),	7,701
Engine No. 11 operated (hours),	2
Engine No. 15 operated (hours),	146

Quantity pumped by Engine No. 10 (gallons),	367,680,000
Quantity pumped by Engine No. 11 (gallons),	110,000
Quantity pumped by Engine No. 15 (gallons),	8,830,000

Cost of pumping:—

Labor,	\$7,397 53
Fuel,	4,929 06
Repairs,	1,203 93
Oil, waste and packing,	198 19
Small supplies,	262 24

Total for station, \$13,990 95

Cost per million gallons pumped,	\$37.1487
Cost per million foot gallons, . . . . .	.1316

Hyde Park Pumping Station.

All of the water supplied to the southern extra high-service district during 1918 was repumped at the Hyde Park pumping station from the southern high-service mains. Only the usual minor repairs have been necessary during the year.

The southern extra high-service pumping statistics for 1918 are as follows:—

Total quantity pumped (gallons),	296,000,000
Daily average quantity pumped (gallons),	811,000
Bituminous coal used (pounds),	321,616
Anthracite screenings used (pounds),	470,602
Average lift (feet),	137.23
Engine No. 13 operated (hours),	3,214
Engine No. 14 operated (hours),	1,801
Quantity pumped by Engine No. 13 (gallons),	173,060,000
Quantity pumped by Engine No. 14 (gallons),	122,940,000

Cost of pumping:—

Labor,	\$7,069 20
Fuel,	2,245 34
Repairs,	287 56
Oil, waste and packing,	189 96
Small supplies,	268 65

Total for station, \$10,060 71

Cost per million gallons pumped,	\$33.9889
Cost per million foot gallons, . . . . .	.2477

The pumps at this station are operated about 11 hours per day, the boilers being maintained with banked fires at other times and the machinery cannot be operated at maximum efficiency under these conditions.

Additional information regarding the operation of the pumping engines at the various stations is given in tables in Appendix No. 2.

DISTRIBUTION RESERVOIRS.

The locations, elevations and capacities of the distribution reservoirs of the Metropolitan Water Works are shown by the following table: —

DISTRIBUTION RESERVOIRS AND LOCATIONS.	Elevation of High Water. ¹	Capacity in Gallons.
Low Service:—		
Spot Pond, Stoneham and Medford,	163.00	1,791,700,000
Chestnut Hill Reservoir, Brighton District of Boston, . . .	134.00	300,000,000
Weston Reservoir, Weston,	200.00	200,000,000
Mystic Reservoir, Medford,	157.00	26,200,000
Northern High Service: —		
Fells Reservoir, Stoneham,	271.00	41,400,000
Bear Hill Reservoir, Stoneham,	300.00	2,450,000
Northern Extra High Service: —		
Arlington Standpipe, Arlington,	442.00	550,000
Southern High Service: —		
Fisher Hill Reservoir, Brookline,	251.00	15,500,000
Waban Hill Reservoir, Newton,	264.50	13,500,000
Forbes Hill Reservoir, Quincy,	192.00	5,100,000
Forbes Hill Standpipe, Quincy,	251.00	330,000
Southern Extra High Service: —		
Bellevue Reservoir Steel Tank, West Roxbury District of Boston, .	375.00	2,500,000
Total,	—	2,399,230,000

¹ Elevation in feet above Boston City Base.

By arrangement with the city of Chelsea a portion of the maintenance of its reservoir on Powder Horn Hill is assumed by the department, and the reservoir is used by the department when necessary in connection with the supplying of water to the northern high-service district. This reservoir has a capacity of 1,000,000 gallons with high-water line at elevation 196.6. The reservoir was

in service until February 1, when it was drawn down on account of leakage through the embankment, and a crack was found between the original brick lining and the new concrete lining which was placed on the upper portion of the inner slope in 1904. The water in the reservoir was kept below this crack until November, when the reservoir was drained. During November and December the loose material was dug out of the crack, which then varied from 2 to 7 inches in width, and repairs were made with a mixture of Barber Positive Seal Asphalt and pea stone applied hot. After the material had cooled it was thoroughly rammed and sealed with a brush coat of asphalt. The total cost of the work, which was not entirely completed at the close of the year, will be about \$400.

Water is delivered into the Chestnut Hill Reservoir from the storage reservoirs by gravity and is pumped from that reservoir for the low-service and southern high-service districts.

Water is delivered from the Sudbury Reservoir through the Weston Aqueduct by gravity and is then supplied to the low-service works through the Weston Aqueduct supply mains by gravity.

Water for the northern high-service district is pumped from Spot Pond to the Fells and Bear Hill reservoirs. For the northern extra high-service district water is pumped from the low-service pipe lines to the steel tank at Arlington Heights and for the southern extra high-service water is pumped from the southern high-service pipe lines to the Bellevue Reservoir.

Weston Reservoir.

At the Weston Reservoir the inlet chamber, open channel, reservoir and screen chamber and the terminal chamber on the lower Weston Aqueduct were cared for. The screens, beaches, lawns, walks, driveways, drains and fences were given the necessary attention, but on account of scarcity of labor no special work was attempted. The ironwork in the screen and channel chambers, the stop-planks in the screen chamber and the iron fences at the Ash Street bridge and the terminal chamber were painted.

Chestnut Hill, Fisher Hill and Waban Hill Reservoirs.

The work of caring for the gate-houses and screens and the shrubs, walks, drives and grounds at the Chestnut Hill, Fisher Hill and Waban Hill reservoirs was attended to with a smaller force than

usual because of the scarcity of labor. The Bradlee basin of the Chestnut Hill Reservoir and the Fisher Hill and Waban Hill reservoirs were in service throughout the year. The Lawrence basin of the Chestnut Hill Reservoir was out of service from May 13 to June 19.

The ironwork, woodwork and screens at all the gate-houses have been painted and repaired where necessary. Some of the iron pipe rails and the concrete posts of the fence built in 1916 along Beacon Street on the southerly shore of the Bradlee basin have been repaired at three points where injured by automobiles.

The work of installing wires for electric lights, private telephone and watchmen's clock circuits in underground conduits between the buildings at Chestnut Hill Reservoir has been completed. All wires at this place are now underground. In connection with this work a 1½-inch iron pipe was laid from pumping station No. 1 under Beacon Street to effluent gate-house No. 2 so that steam will be available for removing anchor ice in cold weather if necessary.

The driveway has been resurfaced where disturbed by the construction of the new garage and shrubs have been set out at the garage and other points where required to replace dead or injured stock. Over 500 shrubs of various kinds and 15 Douglass spruce trees 4 to 5 feet high were used for this work.

Spot Pond, Fells and Bear Hill Reservoirs.

The gate-houses, walks, shrubs and grounds have received the usual attention. The gates have been operated and the screens cleaned as required. The row boat and motor boat at Spot Pond have been painted and varnished. The engine in the motor boat was overhauled and the boat-house and tool-house painted. Electric light fixtures have been installed in the department house at Spot Pond and the interior finish has been painted. About 400 linear feet of 2-inch fibre duct has been laid underground between the house, barn and pumping station and a No. 8 twin-wire lead sheathed electric light cable has been installed.

Bellevue and Forbes Hill Reservoirs.

Bellevue Reservoir has been in use throughout the year. The stairway and overflow pipe were cleaned and painted with black varnish. At Forbes Hill the steel tank has been in regular use all

the year and the reservoir has been held full of water for emergency use. The iron stairs leading to the top of the tower were scraped and painted and the interior of the gate chamber has been cleaned and painted. The work of setting fence posts on the south side of the lot has been continued but no wire has been strung on account of scarcity of labor. A slight leak developed in the concrete wall of the gate-house early in the year but has not changed materially during the year.

Arlington and Mystic Reservoirs.

The Arlington standpipe has been in use throughout the year. As it is planned to replace this standpipe with a larger one before many years the painting of the steelwork has been deferred. The grounds about the standpipe have been cared for as usual by the town of Arlington, by agreement.

The Mystic Reservoir has not been in service during the year but was kept full of water for emergency use. Some minor repairs were made to the gate-house and the concrete walk on top of the embankment. On March 18 Tufts College was granted permission to use the reservoir embankments in connection with the instruction of students for military service.

Mystic Lake, Conduit and Pumping Station.

As these structures are not now used for water supply purposes they have been given only the necessary attention to keep them in repair. The elevation of the water in Mystic Lake has been regulated as required and minor repairs were made at the bridge and in the gate-house near the dam.

Repairs begun last year at the department house and stable near the pumping station were practically completed at the close of the year.

On March 23 Tufts College was granted permission to use the old pumping station for training men for aviation service.

Grounds at Arlington and Hyde Park Pumping Stations.

The lawns, shrubs, driveways and grounds at the Arlington and Hyde Park pumping stations have been kept in good condition. The fence at the Hyde Park station has been repaired and painted.

The side track at the Arlington station has been repaired by the Boston & Maine Railroad at a cost of \$77.11.

Protection of Water Supply in Distribution Reservoirs.

Special watchmen were employed at the Chestnut Hill, Fells, Mystic and Bear Hill reservoirs and at Spot Pond, as required during the year, to prevent violation of the sanitary rules and regulations, at a cost of \$1,483.04.

DISTRIBUTION PIPE LINES.

The length of distribution pipe lines owned and operated by the department at the close of the year is 124.27 miles, an increase of 1.93 miles during the year. In connection with the maintenance of the pipe lines they have been regularly patrolled and the work of municipalities and public service corporations in the vicinity of the pipe lines has been inspected. The location of each valve chamber has been plainly stenciled on objects along the line so that valves can be readily found when desired. The valves have been kept in good working condition, the valve chambers were cleaned and the frames and covers were regulated to conform to the grades of the streets where necessary. The covers over important valves were covered with salt during cold weather to keep them free from ice.

Low-service Mains in East Boston.

In September, on account of increased activity due to the war, the Boston & Lockport Block Company acquired the property of the city of Boston located east of its premises, between Condor Street and Chelsea Creek, East Boston, for the purpose of enlarging its plant. In connection with this development the Company desired to fill in the portion of the land in which the department maintains two 24-inch water mains, under an easement acquired from the city in 1900, and was granted permission to do so on condition that the pipes should be raised, that the department employees should do any portion of the work deemed necessary to obtain satisfactory results and that the entire cost of the work should be paid by the Company.

On account of the soft mud and silt at this place the pipe lines were originally laid on a pile foundation. The work of raising the pipes was begun September 28. Two 10-inch spruce piles were driven at each pipe length, one on each side of the pipe and about 5 feet on centres and 2 feet back of the bell of the pipe. About half of the piles were driven from a lighter and the others were

driven from a land machine. The piles varied from 20 to 40 feet in length and were driven from 10 to 30 feet below the surface of the mud. The tops of the piles were left at least 10 feet above the top of the pipes and temporary caps were bolted near the top of the piles to support the lifting screws and slings with which the pipe lines were raised for a maximum distance of about 6 feet. The pipe lines were raised in five sections, the longest being 330 feet in length. After the pipes were raised two permanent 6-inch x 12-inch hard pine girder caps were bolted in place at each pile bent to support the pipes. The screws and slings were then removed and the top portion of the piles were cut off.

The easterly line was raised for a length of 451 feet and the westerly line for a length of 456 feet southerly from the bulkhead line at Chelsea Creek, one line being kept in service while the other was being raised, with the exception of a few hours while the work of capping and connecting the lines was in progress. At the bulkhead line the connection of the pipes which were not raised with the pipes which were raised was made by using two $\frac{1}{16}$ curves in each line. The work of cutting and making up the lines and of recalking the joints was done by the department force; the rest of the work was done by the Company.

The work was greatly delayed by lack of men and other causes and at the end of the year although both lines had been raised the easterly line had not been connected at the southerly end so that it could be put into service and only slight progress had been made in filling around the pipes.

In connection with this work a slight relocation of our right of way from Condor Street to the pipe lines is to be made by agreement with the Company.

Pipe Bridges.

Minor repairs were made to pipe bridges over the Boston & Maine Railroad at College Avenue in Medford and Walnut Street in Somerville, also to the bridges over the Pines River at the Saugus-Revere boundary line and over the Saugus River at the Saugus-Lynn boundary line.

All of the pipe boxes are in fair condition with the exception of the one at Chelsea north bridge over the Mystic River, at Chelsea, and the Walnut Street bridge over the Boston & Maine Railroad in Somerville, which should be repaired during the coming season.

Pipe Yards.

Minor repairs were made at the office, carpenter shop and long shed at the Chestnut Hill pipe yard. During the extreme cold weather the pipes of the heating system on the second floor of the building at the Glenwood pipe yard froze and burst. They were removed and pipes leading to the second floor were capped. A radiator was installed in one room on the second floor for use until permanent repairs are made.

Meters, Regulating Valves and Recording Pressure Gages.

There are now 69 Venturi meters varying in size from 6 inches to 60 inches in diameter; 7 Hersey detector meters; 3 Hersey disc meters and 1 Hersey torrent meter connected with the distribution mains, which, with the exception of 9 of the Venturi meters, were used for measuring the water supplied to the various municipalities in the Metropolitan Water District.

In connection with the operation of these meters two men were employed continuously during the year and some additional labor was furnished for this work from time to time as required. The Venturi meter registers were read and the clocks wound twice each week, and they were given such additional attention as was necessary to keep them in repair and operating satisfactorily.

There are now 8 pressure regulating valves installed on the distribution mains for reducing the pressure of water supplied to portions of Chelsea, East Boston and Hyde Park, and to Nahant, Revere, Swampscott and Winthrop. These valves have received the usual attention and have controlled the pressures in a satisfactory manner.

Recording pressure gages have been maintained at 20 stations on the Metropolitan Water Works, and the table in Appendix No. 2, showing the elevation of the hydraulic grade line in feet above Boston city base at 17 of these stations for each month during the year, has been prepared from the charts.

The service pipes leading to the recording gages at Malden City Hall and Mystic Reservoir froze during the cold weather in January and considerable time was spent in thawing them. On account of a leak on the service pipe to the recording gage at Lex-

ington Town Hall it was abandoned and a new $\frac{5}{8}$ -inch lead pipe was laid in a 4-inch x 4-inch box filled with slaked lime from the Town Hall to the sidewalk, where a connection was made with an abandoned lead service pipe of the Lexington Water Works. On account of the cold weather and discontinuance of heat at the Somerville Public Library the recording gage at this place was shut off on February 7 and was not turned on again until May 3.

Breaks and Leaks.

There were two breaks in the distribution mains during the year. The first occurred June 7 in the 12-inch northern high-service main at Atlantic Avenue near Belle Isle inlet, in Revere, and was caused by electrolysis. A hole about 2 inches in diameter was found on the bottom of one of the pipes. This pipe was removed and a new pipe laid. The pipe line was out of service from 1.30 P.M. June 7 to 12.15 A.M. June 8. On account of the location of the break very little damage was done by the water. The repairs cost \$151.98. The second break occurred Sunday, September 15, in the 30-inch northern high-service main at Cross Street near Main Street, in Malden. The break occurred about 5.45 A.M. and the water was shut off shortly after 7 A.M. Repairs were started at once, the broken pipe was removed and a new pipe laid and the line put into service again at 7 P.M. The water from this break did considerable damage to streets in the vicinity. Several catch basins were filled with gravel and the water entered nine cellars through basement windows and doorways and rose to a depth of from a few inches to $2\frac{1}{2}$ feet. There was also some damage to lawns and gardens in the vicinity. During the time that the line was out of service the consumption in the high-service districts of Everett, Chelsea and East Boston, and the entire consumption in Revere, Winthrop, Swampscott and Nahant was supplied from local standpipes and reservoirs and a small quantity of water which was by-passed around the break through the local pipes in Malden. The repairs cost \$566.57.

Emergency Pipe Line Service.

The two $\frac{3}{4}$ -ton auto trucks, equipped with special bodies and gate operating attachments, put into service in 1917 for operating valves quickly in case of emergency, have been in service during the entire

year. One of the trucks is stationed at the Chestnut Hill pipe yard in Brighton for use on the southern portion of the distribution pipe system and the other is stationed at the Glenwood pipe yard in Medford for use on the northern portion of the pipe system. Men are kept on duty ready to operate the trucks in case of emergency at any time during the day or night.

CONSUMPTION OF WATER.

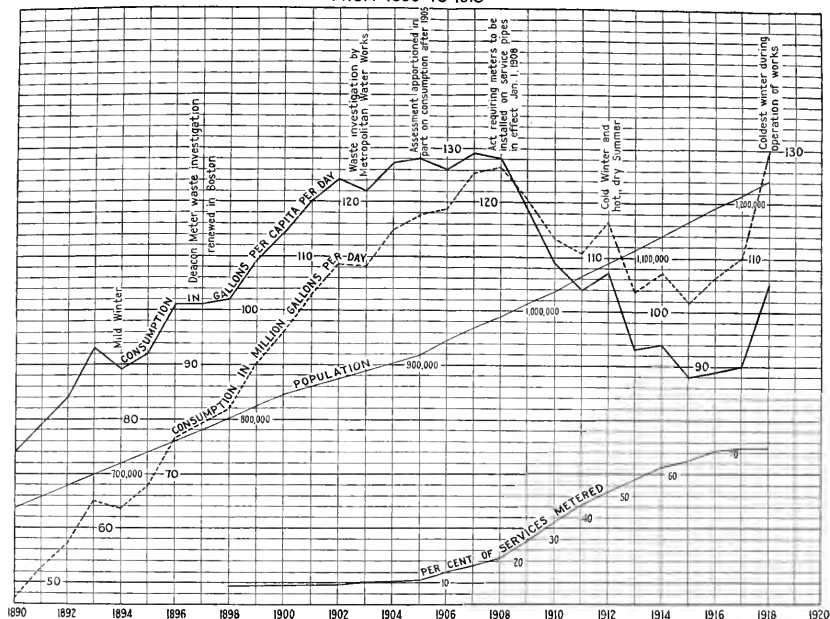
The total quantity of water furnished to the 18 municipalities supplied from the Metropolitan Water Works during the year, as measured by the water works meters was 47,363,860,000 gallons, which is equivalent to an average consumption of 129,764,000 gallons per day. On the basis of an estimated population of 1,241,460 this is equivalent to a consumption of 105 gallons per capita per day.

By reference to the accompanying diagram it may be seen that since 1915 the consumption of water has increased materially notwithstanding the installation of additional meters. The increase in consumption during 1918 is 19,731,700 gallons per day or 17.93 per cent. of the consumption during the previous year, and the increase in per capita consumption is 15 gallons per day or 16.67 per cent. This increase has been due to the unusual industrial activity in connection with the war and to the unprecedented cold winter, and it is therefore reasonable to expect a material decrease in consumption with a return to normal conditions.

It is of interest to note that although 72.47 per cent. of the service pipes in the Metropolitan Water District are now equipped with meters, more than half of the increase in consumption during the past year is due to intentional waste of water during January, February and March to prevent freezing of service pipes. For an entire week in February the consumption averaged 171,099,000 gallons per day as compared with an average consumption of 117-, 085,000 gallons per day for a week in December when the minimum use of water occurred.

The extent to which the frost penetrated into the ground is indicated by the fact that more than 11,000 service pipes and 300 main pipes were frozen; over 1,500 leaks were discovered and about 15,000 meters were removed in the Metropolitan Water District during the winter by the local water departments.

POPULATION, CONSUMPTION OF WATER AND PER CENT OF SERVICES METERED
IN THE
METROPOLITAN WATER DISTRICT
AS SUPPLIED IN 1918
FROM 1890 TO 1918



The average daily consumption of water in each of the municipalities supplied from the Metropolitan Water Works during 1917 and 1918, as measured by the Metropolitan Water Works meters, is as follows:—

	Estimated Popula- tion, 1918.	AVERAGE DAILY CONSUMPTION.				
		1917.		1918.		Increase in Gallons.
		Gallons.	Gallons per Capita.	Gallons.	Gallons per Capita.	
Arlington,	16,910	997,100	61	1,290,300	76	293,200
Belmont,	9,330	474,800	53	577,700	62	102,900
Boston,	790,330	82,073,200	106	94,634,000	120	12,560,800
Chelsea,	47,570	3,188,500	69	3,501,200	74	312,700
Everett,	40,700	3,033,000	76	3,365,800	83	332,800
Lexington,	5,900	426,700	74	494,600	84	67,900
Malden,	52,150	2,419,300	47	3,254,700	62	835,400
Medford,	34,600	1,641,300	49	2,161,200	62	519,900
Melrose,	17,870	902,900	51	1,180,600	66	277,700
Milton,	9,250	375,000	41	434,500	47	59,500
Nahant,	1,530	155,300	105	228,200	149	72,900
Quincy,	44,200	2,706,800	63	4,632,100	105	1,925,300
Revere,	29,350	1,615,400	58	1,975,500	67	360,100
Somerville,	92,930	6,676,100	73	7,433,200	80	757,100
Stoneham,	7,760	531,300	69	617,700	80	86,400
Swampscott,	7,960	503,800	65	606,100	76	102,300
Watertown,	18,520	1,584,600	89	2,434,700	131	850,100
Winthrop,	14,600	727,200	52	941,900	65	214,700
District,	1,241,460	110,032,300	90	129,764,000	105	19,731,700

This table shows that there was an increase in consumption in every city and town in the District. On account of the magnitude of the war industries in Quincy and Watertown the percentage of increase in consumption is much greater in these places than in the other municipalities. The consumption by districts in 1918 as compared with 1917 is as follows:—

	Gallons per Day, 1918.	INCREASE FROM 1917.	
		Gallons per Day.	Percent- age.
Southern low-service district, embracing the low-service district of Boston, with the exception of Charlestown and East Boston, . . .	46,838,000	4,088,900	9.56
Northern low-service district, embracing the low-service districts of Somerville, Chelsea, Malden, Medford, Everett, Arlington, Charlestown and East Boston, . . .	26,428,300	4,010,000	17.89
Southern high-service district, embracing Quincy and Watertown, the high-service districts of Boston, and portions of Belmont and Milton, . . .	44,631,800	9,457,400	26.89
Northern high-service district, embracing Melrose, Revere, Winthrop, Swampscott, Nahant and Stoneham, and the high-service districts of Somerville, Chelsea, Malden, Medford, Everett and East Boston, . . .	10,001,500	1,877,100	23.10
Southern extra high-service district, embracing the higher portions of Hyde Park, Milton and West Roxbury, . . .	793,600	105,200	15.28
Northern extra high-service district, embracing Lexington and the higher portions of Arlington and Belmont, . . .	1,070,800	193,100	22.00
Totals,	129,764,000	19,731,700	17.93

Installation of Meters on Service Pipes.

Chapter 524 of the Acts of the year 1907, as amended by chapter 177 of the Acts of the year 1909, requires that in municipalities supplied with water from the Metropolitan Water Works meters shall be set each year on all new service pipes and on 5 per cent. of all service pipes that were without meters on December 31, 1907, and that it shall be the duty of the Metropolitan Water and Sewerage Board to supervise and promote the enforcement of the provisions of this act.

By the provisions of chapter 269 of the Special Acts of the year 1917 and of chapter 45 of the Special Acts of the year 1918 the city of Boston is relieved from the requirement that meters shall be set each year on 5 per cent. of all services that were not equipped with meters on December 31, 1907, from April 10, 1917, to April 10, 1919.

Information regarding the installation of meters on service pipes by the municipalities supplied with water from the Metropolitan Water Works to December 31, 1918, is given in the table on page 109. From this table it may be seen that the total number of meters set on both old and new service pipes since 1907 in each of the municipalities with the exception of the city of Malden and the town of Nahant is equal to or exceeds the total number of meters required by the statute to be set to December 31, 1918, although there has been some departure from an exact compliance with the law in certain years.

CITY OR TOWN.	Number of Meters required to be set on Old Services Each Year.	METERS SET ON OLD SERVICES.					NEW SERVICES.					Meters in Use December 31, 1918.	Per Cent. of Services metered December 31, 1918.			
		1908 to 1910, inclusive.	1911 to 1915, inclusive.	1916.	1917.	1918.	Totals.	1908 to 1917, inclusive.	1918. ¹	Totals.	1908 to 1917, inclusive.			1918. ¹	Totals.	
Arlington,	55	227	737	-	-	-	964	605	1,368	68	1,436	1,395	68	1,463	3,171	100.00
Bellmont,	-	-	-	-	-	-	-	-	1,018	28	1,046	1,018	28	1,046	1,755	100.00
Boston,	4,276	11,068	29,424	5,802	1,247	9	47,550	38,280 ²	16,546	243	16,789	13,077	300	13,386	63,187	59.32
Chelsea,	240	1,733	1,266	2	1	1	3,003	2,640	1,144	18	1,162	1,117	18	1,135	5,184	99.81
Everett,	252	870	1,211	237	223	256	2,797	2,772	953	25	978	893	25	918	6,043	63.06
Lexington,	32	239	300	19	55	-	613	352	551	23	577	529	33	562	1,264	100.00
Malden,	14	113	7	-	-	-	120	154	1,187	66	1,253	1,091	114	1,205	8,192	97.29
Medford,	179	3,339	195	1	103	-	3,638	1,969	2,442	58	2,500	2,484	58	2,542	6,639	100.00
Melrose,	119	2,574	17	1	-	3	2,595	1,309	800	32	832	985	35	1,020	4,190	100.00
Milton,	-	-	-	-	-	-	-	798	798	29	827	798	29	827	2,035	100.00
Nahant,	16	96	78	32	5	0	211	176	318	9	327	255	1	256	737	75.38
Quincy,	230	814	3,631	16	8	-	4,469	2,530	3,935	287	4,222	3,194	164	3,358	10,248	90.46
Rivers,	138	379	1,192	62	72	10	1,715	1,518	1,905	47	1,952	1,702	47	1,749	7,619	76.98
Somerville,	411	1,854	2,427	434	163	82	4,960	4,521	2,077	23	2,100	2,214	39	2,253	13,514	101.16
Stoughton,	65	527	774	1	17	-	1,319	715	306	13	319	306	13	319	1,657	99.52
Swampscott,	21	434	13	-	-	-	447	231	666	32	698	666	32	698	1,954	100.00
Watertown,	-	-	-	-	-	-	-	1,251	946	52	1,303	1,353	52	1,405	3,184	100.00
Winthrop,	100	1,894	18	-	37	-	1,919	1,100	946	15	961	926	15	941	3,031	100.00
Totals,	6,148	26,161	41,290	6,607	1,931	361	76,350	58,872	38,214	1,068	39,282	34,003	1,080	35,083	182,996	132,732
																72.47

¹ The number of new services installed and the number of new services equipped with meters seldom agree for the reason that service pipes are installed but meters are not set until the buildings are permanently occupied.

² Chapter 45 of the Special Acts of the year 1918 exempts the city of Boston from setting meters on old service pipes for a period of one year.

During 1918 1,068 service pipes and 1,441 meters were installed in the municipalities supplied from the Metropolitan Water Works, and at the close of the year 182,996 service pipes and 132,732 meters were in use; 72.47 per cent. of all the service pipes had been provided with meters; in nine of the municipalities all of the service pipes were equipped with meters and in two other municipalities over 99 per cent. of the service pipes were equipped with meters.

WATER SUPPLIED OUTSIDE OF METROPOLITAN WATER DISTRICT.

During the year 557,769,000 gallons of water were supplied from the Metropolitan Water Works for use outside the Metropolitan Water District as follows: —

PLACES SUPPLIED.	Total Quantity (Gallons).	Average Quantity (Gallons per Day).	Number of Days on which Water was supplied.	Amounts charged for Water supplied.
Westborough State Hospital,	59,767,000	163,700	365	\$1,793 01
Town of Framingham: —				
From Sudbury Aqueduct,	232,000,000	635,616	365	5,568 00
From Filter-gallery at Farm Pond, . .	196,600,000	538,630	365	377 04
United States Government: —				
Peddock's Island,	49,246,000	134,900	365	2,660 84
Portion of town of Saugus,	16,377,000	44,900	365	800 00

PROTECTION OF WATER WORKS STRUCTURES.

Measures which were in effect at the beginning of the year for the protection of the water works structures from irresponsible or malicious persons because of the unsettled conditions were terminated December 1.

QUALITY OF THE WATER.

The yearly average results of the chemical analyses, made by the State Department of Health since 1892, and of the biological and bacteriological examinations, made in the Metropolitan Water Works laboratory, of water from service taps in Boston since 1898, are given in tables in Appendix No. 2.

ENGINEERING.

In connection with the maintenance of the works the engineering force has made plans, estimates and reports for various projects and improvements; has made record plans of water works lands and structures and surveys and plans for land purchases and takings; has tested meters; made photographs, blue prints and analyses of coal and oil; calculated yields of watersheds; made current meter gagings; kept hydraulic and meteorological records; summarized power station and pumping station records; cared for the recording pressure gages and supervised various operations carried on by the department.

Appended to this report are tables giving additional information relating to the operations of the Metropolitan Water Works for the year 1918 and the usual water works statistics.

Respectfully submitted,

WILLIAM E. FOSS,
Chief Engineer.

Boston, January 2, 1919.

REPORT OF CHIEF ENGINEER OF SEWERAGE WORKS.

To the Metropolitan Water and Sewerage Board.

GENTLEMEN:—The following report of the operations of the Metropolitan Sewerage Works for the year ending December 31, 1918, is respectfully submitted:—

ORGANIZATION.

The Chief Engineer has charge of the design and construction of all new works, and of the maintenance and operation of all the works controlled by the Metropolitan Water and Sewerage Board for removing sewage from the twenty-six municipalities which comprise the Metropolitan Sewerage Districts.

The following assistants have been employed during the year:—

Henry T. Stiff,	Division Engineer, in charge of office and drafting room and of the construction work.
Clarence A. Moore,	Assistant Engineer, in charge of maintenance studies and records and of construction work on the North Metropolitan System.
Arthur F. F. Haskell,	Assistant Engineer, in charge of survey work and field work in connection with the Wellesley Extension construction.
Ralph W. Loud,	Assistant Engineer, in charge of survey work and field work in connection with the Reading Extension construction.
George W. Wood,	Assistant Engineer, on Reading Extension.

In addition to the above, the number of engineering and other assistants employed during the year was 17, which includes 2 superintendents, 2 instrumentmen, 6 inspectors, 2 draftsmen, 3 rodmen and engineering assistants and 2 stenographers.

METROPOLITAN SEWERAGE DISTRICTS.

AREAS AND POPULATIONS.

During the year no changes have been made in the extent of the Metropolitan Sewerage districts.

The populations of the districts, as given in the following table, are based on the census of 1915.

Table showing Ultimate Contributing Areas and Present Estimated Populations within the Metropolitan Sewerage Districts, as of December 31, 1918.

CITY OR TOWN.		Area (Square Miles).	Estimated Population.
North Metropolitan District.	Arlington,	5.20	17,320
	Belmont,	4.66	9,520
	Boston (portions of),	3.45	110,990
	Cambridge,	6.11	113,010
	Chelsea,	2.24	48,200
	Everett,	3.34	41,160
	Lexington, ¹	5.11	4,350
	Malden,	5.07	52,650
	Medford,	8.35	35,230
	Melrose,	3.73	18,020
	Reading,	9.82	7,780
	Revere,	5.86	29,990
	Somerville,	3.96	93,870
	Stoneham,	5.50	7,800
	Wakefield,	7.65	13,770
South Metropolitan District.	Winchester,	5.95	10,830
	Winthrop,	1.61	14,880
	Woburn,	12.71	17,000
		100.32	646,270
	Boston (portions of),	24.96	283,900
	Brookline,	6.81	37,330
	Dedham, ¹	9.40	12,100
	Milton,	12.59	9,350
	Newton,	16.88	45,650
	Quincy,	12.56	44,740
	Waltham,	13.63	32,060
	Watertown,	4.04	18,830
	Wellesley,	9.89	7,240
		116.76	491,200
Totals,		211.08	1,137,470

¹ Part of town.

METROPOLITAN SEWERS.

SEWERS PURCHASED AND CONSTRUCTED AND THEIR CONNECTIONS.

During the year there has been built .229 of a mile of Metropolitan sewer within the sewerage districts, so that there are now 113.240 miles of Metropolitan sewers. Of this total, 9.642 miles of sewers, with the Quincy pumping station, have been purchased from cities and towns of the districts. The remaining 103.598 miles of sewers and other works have been constructed by the Metropolitan boards.

The locations, lengths and sizes of these sewers are given in the following tables, together with other data referring to the public and special connections with the systems:—

NORTH METROPOLITAN SEWERAGE SYSTEM.

Location, Length and Sizes of Sewers, with Public and Special Connections.

CITY OR TOWN.	Size of Sewers.	Length in Miles.	Public Connections, December 31, 1918.	SPECIAL CONNECTIONS.	
				Character or Location of Connection.	Number in Operation.
Boston:—					
Deer Island, .	4' 0" to 9' 0", . . .	1.653	4	—	—
East Boston, .	9' 0" to 1' 0", . . .	5.467	25	Shoe factory,	1
Charlestown, .	6' 7"×7' 5" to 1' 0", . . .	3.292	15	Middlebrook Wool-combing Co.,	1
Winthrop, . .	9' 0",	2.564	13	Navy Yard,	8
				Private building,	1
				Club house,	1
				Fire Department Station,	1
				Private building,	1
				Bakery,	1
				Rendering works,	1
Chelsea, . . .	8' 4"×9' 2" to 15", . . .	5.230	13	Metropolitan Water Works blow-off,	1
				Chelsea Water Works blow-off,	2
				Naval Hospital,	1
				Metropolitan Water Works blow-off,	1
				Cameron Appliance Co.,	1
Everett, . . .	8' 2"×8' 10" to 4' 8"×5' 1", . . .	2.925	8	Shultz-Goodwin Co.,	1
				Andrews-Wasgatt Co.,	1
				National Metallic Bed Co.,	1
				Linoide Co.,	1
				Factory,	2
				New England Structural Co.,	1
Lexington, . .	—	—	1	—	—
Malden, . . .	4' 6"×4' 10" to 1' 0", . . .	5.844 ¹	34	Metropolitan Water Works blow-off,	1
				Private buildings,	183 ²

¹ Includes 1.84 miles of sewer purchased from the city of Malden.

² Mostly buildings connected with sewers formerly belonging to city of Malden but later purchased by the Metropolitan Sewerage Commission in accordance with chapter 215 of the Acts of 1898 and by the Metropolitan Water and Sewerage Board in accordance with chapter 512 of the Acts of 1911 and made parts of the North Metropolitan Sewerage System.

NORTH METROPOLITAN SEWERAGE SYSTEM — *Concluded.**Location, Length and Sizes of Sewers, with Public and Special Connections*
— *Concluded.*

CITY OR TOWN.	Size of Sewers.	Length in Miles.	Public Connections, December 31, 1918.	SPECIAL CONNECTIONS.	
				Character or Location of Connection.	Number in Operation.
Melrose,	4' 6"×4' 10" to 10", . . .	6.099 ¹	38	Private buildings,	115 ²
				Factory,	1
				Railroad station,	1
				Park Department bath house,	1
				Harvard dormitories, . . .	2
				Slaughter-house,	1
				City Hospital,	3
Cambridge,	5' 2"×5' 9" to 1' 3", . . .	7.209	45	Street railway machine shop,	1
				Private buildings,	1
				Factory building,	1
				Tannery,	1
				Slaughter-houses (3), . . .	1
				Car-house,	1
Somerville,	6' 5"×7' 2" to 10", . . .	3.577	12	Somerville Water Works blow-off,	1
				Street railway power-house, .	1
				Stable,	1
				Rendering works,	1
				Railroad scale pit,	1
				Armory building,	1
Medford,	4' 8"×5' 1" to 10", . . .	5.713	24	Private buildings,	9
				Stable,	1
				Police substation,	1
				Tanneries,	6
				Private buildings,	8
				Gelatine factory,	1
				Watch-hand factory,	1
Winchester,	4' 6" to 1' 3",	9.470	27	Stable,	1
				Railroad station,	1
				Felt works,	1
				Town Hall,	1
				Bay State Saw & Tool Co., .	1
				Whitney Machine Co., . . .	1
Stoneham,	1' 3" to 10",	0.010	4	—	—
Woburn,	1' 10"×2' 4" to 1' 3", . . .	0.933	3	Glue factory,	1
				Private buildings,	159 ⁴
Arlington,	1' 6" to 10",	3.520 ³	43	Railroad station,	1
				Car-house,	3
				Post office,	1
Belmont, ⁵	—	—	3	—	—
Wakefield, ⁵	3' 0",	0.086	1	—	—
Revere,	4' 0" to 15",	0.136	3	—	—
Reading,	—	—	—	—	—
		64.028 ⁶	316		547

¹ Includes .736 of a mile of sewer purchased from the city of Melrose.² Mostly buildings connected with a sewer formerly belonging to the city of Melrose but later purchased by the Metropolitan Sewerage Commission in accordance with chapter 414 of the Acts of 1896 and with a sewer extension built in accordance with chapter 436 of the Acts of 1897 by the Metropolitan Sewerage Commission as an outlet for part of the town of Stoneham and made parts of the North Metropolitan Sewerage System.³ Includes 2.631 miles of sewer purchased from the town of Arlington.⁴ Mostly buildings connected with a sewer formerly belonging to the town of Arlington but later purchased by the Metropolitan Sewerage Commission in accordance with chapter 529 of the Acts of 1897 and made a part of the North Metropolitan Sewerage System.⁵ The Metropolitan sewer extends but a few feet into the town of Belmont.⁶ Includes 2.787 miles of Mystic Valley sewer in Medford, Winchester and Woburn, running parallel with the Metropolitan sewer.

SOUTH METROPOLITAN SEWERAGE SYSTEM.

Location, Length and Sizes of Sewers, with Public and Special Connections.

CITY OR TOWN.	Size of Sewers.	Length in Miles.	Public Connections, December 31, 1918.	SPECIAL CONNECTIONS.	
				Character or Location of Connection.	Number in Operation.
Boston: —				Tufts Medical School, . . .	1
Back Bay, . . .	6' 6" to 3' 9", . . .	1.500 ¹	16	Private house, . . .	1
				Administration Building, . . .	1
				Boston Park Department, . . .	1
				Simmons College buildings, . . .	1
Brighton, . . .	5' 9"×6' 0" to 12", . . .	6.010 ²	15	Art Museum, . . .	2
				Abattoir, . . .	3
				Chocolate works, . . .	2
				Machine shop, . . .	1
Dorchester, . . .	3'×4' to 2' 6"×2' 7", . . .	2.870 ³	13	Paper Mill, . . .	1
				Private buildings, . . .	3
				Edison Electric Company Station, . . .	1
Hyde Park, . . .	10' 7"×11' 7" to 4' 0"×4' 1", . . .	4.527	18	Mattapan Paper Mills, . . .	1
				Private buildings, . . .	2
Roxbury, . . .	6' 6"×7' to 4' 0", . . .	1.430	—	Fairview Cemetery buildings, . . .	1
				—	—
West Roxbury, . . .	9' 3"×10' 2" to 12", . . .	7.642	16	Caledonia Grove buildings, . . .	1
				Parental School, . . .	1
				Lutheran Evangelical Church, . . .	1
				Private buildings, . . .	4
Brookline, . . .	6' 6"×7' 0" to 8", . . .	2.540 ⁴	12	Private building, . . .	2
Dedham, . . .	4'×4' 1" to 2' 10"×3' 1", . . .	2.940	7	Private houses, . . .	7
Hull, ⁵ . . .	60" pipe, . . .	0.750	—	Dedham Carpet Mills, . . .	1
Milton, . . .	11'×12' to 8", . . .	3.600	23	—	—
Newton, . . .	4' 2"×4' 9" to 1' 3", . . .	2.911	7	Private buildings, . . .	2
Quincy, . . .	11' 3"×12' 6" to 24" pipe, . . .	6.845	14	Private houses, . . .	7
				Metropolitan Water Works blow-off, . . .	1
Waltham, . . .	3' 6"×4' 0", . . .	0.001	1	—	—
				Factories, . . .	2
Watertown, . . .	4' 2"×4' 9" to 12", . . .	0.750 ⁶	5	Stanley Motor Carriage Co., . . .	1
				Knights of Pythias building, . . .	1
Needham, ⁵ . . .	2' 0"×2' 3" to 2' 3"×2' 6", . . .	4.896	—	—	—
Wellesley, ⁷ . . .	—	—	—	—	—
		49.212	147		45

¹ Includes .355 of a mile of sewer purchased from the city of Boston.² Includes .446 of a mile of pipe and concrete sewers built for the use of the city of Boston; also .026 of a mile of sewer purchased from the town of Watertown.³ Includes 1.24 miles of sewer purchased from the city of Boston.⁴ Includes .158 of a mile of pipe sewer built for the use of the town of Brookline.⁵ Hull and Needham are not parts of the Metropolitan Sewerage District.⁶ Includes .025 of a mile of sewer purchased from the town of Watertown.⁷ The Metropolitan sewer extends but a few feet into the town of Wellesley.

Information relating to areas, populations, local sewer connections and other data for the Metropolitan Sewerage districts appears in the following table: —

North Metropolitan Sewerage District.

Area (Square Miles).	Estimated Total Population.	Miles of Local Sewer connected.	Estimated Population contributing Sewage.	Ratio of Contributing Population to Total Population (Per Cent.).	CONNECTIONS MADE WITH METRO- POLITAN SEWERS.	
					Public.	Special.
100.32	646,270	774.30	579,440	89.7	316	547

South Metropolitan Sewerage District.

110.76	491,200	658.10	372,980	75.9	147	45
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Both Metropolitan Sewerage Districts.

211.08	1,137,470	1,432.40	952,420	83.7	463	592
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Of the estimated gross population of 1,137,470 on December 31, 1918, 952,420, representing 83.7 per cent., were on that date contributing sewage to the Metropolitan sewers, through a total length of 1,432.40 miles of local sewers owned by the individual cities and towns of the districts.

These sewers are connected with the Metropolitan systems by 463 public and 592 special connections. During the current year there has been an increase of 9.31 miles of local sewers connected with the Metropolitan systems, and 4 public and 6 special connections.

CONSTRUCTION.**NORTH METROPOLITAN SEWERAGE SYSTEM.****PART OF SECTION 76. — EXTENSION TO READING.**

The Board entered into a contract with Bruno & Petitti of Boston, Massachusetts, for the construction of about 1,370 feet of sewer extending from the Reading line to the corner of Summer Avenue and Elm Street, Wakefield. Work was commenced under this contract August 3, 1918. The structure consists of 150 feet of 36-inch concrete sewer and 1,220 feet of 24-inch by 27-inch concrete sewer. Average depth of cut 20 feet. Rock was found between Station 26+30 and Station 28+50. The material excavated has been a rather

fine sand which has occasioned difficulty in excavation by reason of the considerable amount of ground water present.

No other attempt at construction has been made on the Reading extension:

SOUTH METROPOLITAN SEWERAGE SYSTEM.

WELLESLEY EXTENSION.

The Wellesley Extension of the High-level Sewer comprises sections 98 to 106 inclusive. Of these sections 102, 103, 104, 105 and 106 are wholly completed and Section 98 practically so.

SECTION 98. — WELLESLEY EXTENSION.

Work on this section was suspended February 15, 1918, owing to the flooded condition of the marshes and was resumed June 11, 1918. During the year 739 feet of sewer have been completed including the river crossing and the connection with the Neponset Valley Sewer. This work has been carried on with great difficulty owing to the nature of the ground and its inaccessibility.

Pile foundation has been placed under all the work constructed during this year.

On December 31, 1918, the section was practically completed, the work remaining being the placing of about 75 yards of concrete, backfilling and clearing up.

SECTION 99. — WELLESLEY EXTENSION.

A contract for the completion of 1,685 feet of this section lying mostly in rock tunnel was entered into by the Board, some particulars of which are as follows:—

Date of contract No. 139,	June 7, 1918.
Name of contractor,	Rowe Contracting Company.
Length of section,	1,685 feet.
Average depth of invert of sewer in tunnel below surface,	25 feet.
Average depth of sewer in open cut,	14 feet.
Dimensions of concrete sewer,	33 inches by 36 inches.
Assistant Engineer in charge of construction,	Arthur F. F. Haskell.

Work was begun on this section July 14, 1918.

By private arrangement between the contractor and the owners of the Nickerson Estate a small dwelling house which stood near

the shaft at Station 5+37 was removed to a new location at the contractor's expense. At the present time shafts have been sunk at Stations 1+03, 5+37 and 13+97 and 510 feet of tunnel boring have been completed. No masonry has yet been placed.

The balance of this section, amounting to 1,550 feet, which is to be built in open trench including a river crossing, has not been placed under contract.

SECTIONS 100 AND 101. — WELLESLEY EXTENSION.

These sections, which include about 7,740 feet of 33-inch by 36-inch concrete sewer in trench and river crossing have not been placed under contract owing to insufficient appropriation.

MAINTENANCE.

SCOPE OF WORK AND FORCE EMPLOYED.

The maintenance of the Metropolitan Sewerage System includes the operation of 7 pumping stations, the Nut Island screen-house and 113.24 miles of Metropolitan sewers, receiving the discharge from 1,432.40 miles of town and city sewers at 463 points, together with the care and study of inverted siphons under streams and in the harbor.

The permanent maintenance force at present includes 149 men, of whom 91 are employed on the North System and 58 on the South System. These are subdivided as follows: North Metropolitan System, 57 engineers and other employees in the pumping stations and 34 men, including foremen, on maintenance, care of sewer lines, buildings and grounds; South Metropolitan System, 35 engineers and other employees in the pumping stations and 23 men, including foremen, on maintenance, care of sewer lines, buildings and grounds.

During January and February the water in Boston Harbor was frozen to an extent not known for many years. This shut off the coal deliveries by water from the East Boston, Deer Island and Charlestown pumping stations. At the East Boston and Charlestown pumping stations it was necessary to have coal delivered by teams.

The general scarcity of coal made it necessary for the Board to call upon the State Fuel Administrator to supply our pumping stations. By this means we were able to get a limited supply which often was of very inferior quality. The low duties obtained in the

pumping stations are due to this fact. To help the fuel situation the sewage in the incoming sewers at the pumping stations was allowed to rise from one to two feet higher than normal level in order to reduce lift.

Mr. Henry J. Wright, who had been connected with the Sewerage Works since 1890 and who for twenty-five years was superintendent of the North Metropolitan Sewerage System, was retired because of age limit on August 6, 1918, according to the provisions of chapter 532 of the Acts of 1911.

Mr. Edward Sheehan, employed as oiler at the Ward Street Pumping Station, was injured in the crank pit of the pumping engine at this station on August 23, 1918, and died in the City Hospital a few hours later.

The regular work of this department, in addition to the operation of the pumping stations, has consisted of routine work of cleaning and inspecting sewers and siphons, caring for tide gates, regulators and overflows, measuring flow in sewers, inspection of connections with the Metropolitan sewers, and the care of pumping stations and other buildings and grounds.

In addition to these regular duties other work has been done by this department as follows:—

DEER ISLAND PUMPING STATION.

The woodwork of the pumping station was painted outside.

It was necessary to clean the 84-inch cast-iron pipes and specials in the new outfall as there was a considerable collection of sand and gravel in the same. This was accomplished by placing closures over the discharge outlets and thereby increasing the current in the pipes.

The temporary outfall at Deer Island used during the construction of the 84-inch cast-iron outfall was flushed and cleaned and sealed at the outer end by means of a cast-iron cover. This cover is held in place at present by two dowels.

All work except the diving was done by maintenance employees.

An arrangement was made with the Public Institutions Department of the city of Boston whereby the ferrying at Shirley Gut is done by employees of that department which greatly reduces the cost to the Commonwealth of the maintenance of this ferry.

EAST BOSTON PUMPING STATION.

A two-story masonry locker for storing pumping station supplies was constructed within the pumping station at the easterly end of the engine room.

The overflow channel on the Chelsea side of the East Boston siphon was cleaned out and the timber work repaired.

Three Metropolitan sewerage manholes on Saratoga Street, East Boston, had to be taken down and rebuilt to accommodate the laying of pavement and sidewalks which were constructed by the Street Department of the city of Boston; the cost of this work to be repaid to the district by the city.

All work was done by maintenance employees.

CHARLESTOWN PUMPING STATION.

It was necessary to take down the brick wall and rebuild the same at the northeast corner of the pumping station owing to disintegration of the mortar by reason of exposure to storm.

A new landing platform at the coal run was constructed.

All work was done by maintenance employees.

REMOVAL OF OLD MYSTIC SIPHON, WINCHESTER.

The 24-inch siphon which crossed the Aberjona River near Wedgemere Station and which was built by the city of Boston in connection with the construction of the old Mystic Valley Sewer was removed at the request of citizens of Winchester. A connection was made between the old Mystic Valley Sewer and the Metropolitan trunk sewer at Station 4+55. Section 44 of the latter and that part of the old Mystic Sewer between this point and the location of the siphon is discontinued.

All work was done by maintenance employees.

NUT ISLAND SCREEN-HOUSE.

The harbor ice which was of unusual thickness in this vicinity damaged the wharf at Nut Island to such an extent that it was necessary to drive twenty oak piles and do other work of repairs. This was accomplished by G. M. Bryne, Contractor, who furnished piles, machinery and a foreman who worked in conjunction with the maintenance employees.

The stable, locker building, boat house and fences of the stock yard and the railings at the wharf were painted during the year.

Concrete gutters and about 150 feet of concrete fence were constructed at the southerly end of the road leading to Nut Island screen-house.

All work was done by maintenance employees.

QUINCY PUMPING STATION.

The woodwork of this station was cleaned and painted during the year.

All work was done by maintenance employees.

GOVERNMENT USE OF OLD 24-INCH QUINCY FORCE MAIN.

The sewerage connection of the shipbuilding plant at Squantum, Quincy, with the 24-inch cast-iron force main in Squantum Street, mentioned in last year's report, was put in operation early in 1918. The average discharge through the force main has been at the rate of about 125,000 gallons per 24 hours. This sewage is discharged through the Boston Main Drainage outfall works at Moon Island.

GASOLENE IN PUBLIC SEWERS.

The efforts to improve the condition of the Metropolitan sewers in regard to dangers resulting from the introduction of gasoline into the same have been continued throughout the year and have been successful.

An inspector has been employed in this department whose duty it is to visit existing garages and see that the separators are kept in proper condition, also to enforce the regulation concerning the installation of such separators at all newly constructed garages.

During the year 47 new garages and other establishments using gasoline have been connected with the local sewer systems which discharge into the Metropolitan sewers. While the presence of gasoline in the Metropolitan sewers is noted occasionally, the condition has been greatly improved.

The following tables show the particulars in regard to establishments known to be using gasoline and which are connected with the public sewerage systems of the different municipalities in the Metropolitan sewerage districts.

NORTH METROPOLITAN SEWERAGE DISTRICT.

Table showing Number of Places connected with Public Sewers where Gasolene is used and Progress of Work of installing Separators to December 31, 1918.

CITY OR TOWN.	Number of Places connected with Sewer.	Number of Places originally having Acceptable Separators.	Number of Places where Changes have been made.	Number of New Garages built, 1918.
Arlington,	6	-	3	-
Belmont, ¹	4	-	3	-
Boston: —				
Charlestown District,	22	-	19	3
East Boston District,	22	-	17	5
Cambridge, ²	95	-	94	5
Chelsea,	22	-	18	4
Everett,	15	-	14	1
Lexington,	-	-	-	-
Malden,	21	-	20	1
Medford,	14	-	13	1
Melrose,	5	-	5	-
Revere,	9	-	3	-
Somerville,	41	8	32	1
Stoneham,	6	-	6	-
Wakefield,	6	-	6	-
Winchester,	14	-	14	-
Winthrop,	4	-	4	-
Woburn,	3	-	3	-
Reading, ³	-	-	-	-
Totals,	309	8	274	21

¹ Washstand discontinued.

² Storer's garage; no separator.

³ Not yet connected with Metropolitan sewer.

SOUTH METROPOLITAN SEWERAGE DISTRICT.

Table showing Number of Places connected with Public Sewers where Gasolene is used and Progress of Work of installing Separators to December 31, 1918.

CITY OR TOWN.	Number of Places connected with Sewer.	Number of Places originally having Acceptable Separators.	Number of Places where Changes have been made.	Number of New Garages built, 1918.
Boston: —				
Hyde Park District,	14	—	8	—
West Roxbury District,	26	10	16	6
Back Bay District,	48	22	26	—
Brighton District,	50	22	28	7
Dorchester District,	31	20	11	4
Brookline,	63	9	54	3
Dedham,	3	3	—	—
Milton,	1	1	—	—
Newton,	41	18	23	3
Quincy,	15	—	15	1
Waltham,	6	5	1	1
Watertown,	16	3	13	1
Wellesley, ¹	—	—	—	—
Totals,	314	113	195	26

¹ Not yet connected with Metropolitan sewer.

DRAINAGE FROM TANNERIES, GELATINE AND GLUE WORKS IN WINCHESTER, WOBURN AND STONEHAM.

Four men and a foreman have been employed during a part of the year in flushing and cleaning the Metropolitan sewers through the tannery districts in Winchester, Woburn and Stoneham.

All the tanneries and glue works of the district now have settling tanks of substantial size. This method of treatment has very greatly reduced the amount of sludge material entering the Metropolitan sewers.

The following table gives details of settling tanks introduced to date, showing the operations of same with the amount of sludge collected and removed: —

Table of Semi-fluid Sludge removed from Settling Basins at the Tanneries, Gelatine and Glue Works in Winchester, Woburn and Stoneham, Year ending December 31, 1918.

LOCATION OF BASIN.	Basin put in Operation.	Inside Measurement of Basin (Feet).	Number of Times cleaned during the Year.	Average Quantity Semi-fluid Sludge removed during the Year (Cubic Yards).	Total Quantity Semi-fluid Sludge removed during the Year (Cubic Yards).
Beggs & Cobb Company, Basin No. 1, ¹	Jan. 15, 1910	47.0 × 23.0	-	-	-
Beggs & Cobb Company, Basin No. 2, ¹	May 9, 1910	47.0 × 23.0	-	-	-
Beggs & Cobb Company, Basin No. 3, ¹	Oct. 19, 1911	51.0 × 25.0	-	-	-
Beggs & Cobb Company, "Rotary Screen Process," ²	Dec. 12, 1917	-	- ³	-	172.00
S. C. Parker & Son, ⁴	Aug. 1, 1910	48.3 × 23.0	-	-	-
American Hide and Leather Company, Factory D.	Nov. 15, 1910	48.0 × 23.1	8	139.50	1,116.00
Dorington Leather Company,	Dec. 10, 1910	47.2 × 23.0	6	106.84	641.04
E. Cummings Leather Company,	Nov. 1, 1910	45.9 × 22.6	6	97.60	585.60
W. P. Fox & Sons,	July 12, 1910	47.8 × 22.6	13	270.40	3,515.20
Thayer & Foss,	Sept. 15, 1910	48.1 × 23.1	4	209.80	839.20
Morris Kaplan, ⁴	Jan. 9, 1911 {	46.8 × 22.9	-	-	-
		4.0 × 4.0	50	1.00	50.00
Van Tassell Leather Company, ⁴	May 1, 1911 {	10.2 × 14.5	-	-	-
		43.8 × 19.5	4	102.00	408.00
American Glue Company,	Oct. 1, 1910	47.1 × 23.0	4	136.36	545.44
J. O. Whitten Company,	1902 {	35.5 × 24.7	22	58.74	1,292.28
		67.2 × 12.0	28	8.50	238.00
Total,	-	-	-	-	9,402.76

¹ Basins filled up temporarily.

² By permission of the Board, dated July 25, 1917, effluent formerly passing through three settling basins has been conducted through "Riensch-Wurl" screens and is allowed to enter the Metropolitan Sewer by a special 15" branch.

Permission was granted with the provision that all existing connections and settling basins shall be left intact and ready for use if necessary.

³ Daily, continuous.

⁴ Not used in 1918.

NORTH METROPOLITAN SEWERAGE SYSTEM.

Table showing Cities and Towns delivering Sewage to this System; Approximate Miles of Sewers connected; Estimated Populations and Areas now contributing; Total Areas ultimately to contribute, and Present Populations on Such Areas; Ratios of Present Contributing Areas to Ultimate Areas, and Ratios of Populations now contributing to Present Total Populations.

[Populations estimated as of December 31, 1918.]

CITIES AND TOWNS.	Miles of Local Sewers connected.	Separate or Combined.	Number of Connections with Local Sewers.	Estimated Number of Persons served by Each House Connection.	Estimated Population now contributing Sewage.	Estimated Present Population.	Estimated Area now contributing Sewage.	Area ultimately to contribute Sewage.	Ratio of Contributing Population to Present Total Population.	Ratio of Contributing Area to Ultimate Area.
Boston (Deer Island),	.70	Separate,	—	—	520 ¹	520 ¹	Sq. Miles.	Sq. Miles.	Per Cent.	Per Cent.
Winthrop,	32.43	Separate,	3,013	4.90	14,760	14,880	1.40	1.61	99.2	87.0
Boston (East Boston),	33.97	Separate and combined,	5,110	13.20	67,450	70,470	1.17	2.18	95.7	53.7
Chelsea,	31.01	Separate and combined,	4,248	10.90	46,300	48,200	1.14	2.24	96.1	50.9
Everett,	48.02	Separate and combined,	5,132	7.00 ²	35,920	41,160	2.00	3.34	87.3	59.9
Malden,	66.46	Separate,	7,059	6.70 ²	47,300	52,650	3.14	5.07	89.8	61.9
Melrose,	39.17	Separate,	3,358	4.50 ²	15,110	18,020	1.88	3.73	83.9	50.4
Boston (Charlestown),	21.69	Separate and combined,	5,438	7.30	39,700	40,000	0.67	1.27	99.2	52.8
Cambridge,	135.24	Separate and combined,	16,815	6.65	111,820	113,010	5.05	6.11	98.3	82.7
Somerville,	101.57	Separate and combined,	16,002	5.75	92,010	93,870	3.50	3.96	98.0	88.4
Medford,	65.21	Separate,	6,136	5.60 ²	34,360	35,250	3.16	8.35	97.5	37.8
Worcester,	32.18	Separate,	2,004	5.20 ²	10,420	10,830	1.53	5.95	96.2	25.7
Woburn,	15.52 ³	Separate,	1,248	5.80 ²	7,240	17,000	1.02	12.71	42.6	8.0
Stonham,	13.46	Separate,	954	4.70 ²	4,800	7,800	0.70	5.50	57.4	12.7
Arlington,	32.32	Separate,	2,375	5.80 ²	13,780	17,220	1.97	5.20	80.0	37.9
Belmont,	22.00	Separate,	1,323	6.00 ²	8,430 ⁴	9,520	1.34	4.66	88.6	28.8
Wakefield,	14.26	Separate,	820	5.60 ²	4,500	13,770	0.60	7.65	33.3	7.8
Lexington,	6.51	—	69	4.30	300	4,350	0.23	5.11	6.9	4.5
Revere, ⁵	42.48	Separate,	3,069	6.80	24,950	29,990	2.08	5.86	83.2	35.5
Reading, ⁵	—	—	—	—	—	7,780	—	9.82	—	—
Totals,	774.30	—	84,773	6.80	579,440	6,6270	32.58	100.32	89.7	32.5

¹ Estimated by Supt. Henry A. Higgins of the institution on Deer Island.

² Estimated from assessors' statement of the number of houses in the city or town on April 1, 1918, and the population from census of 1915.

³ Exclusive of Mystic valley sewer and tanneries.

⁴ Including 2 connections with McLean Hospital, having an estimated population of 489.

⁵ Reading not connected.

SOUTH METROPOLITAN SEWERAGE SYSTEM.

Table showing Cities and Towns delivering Sewage to this System; Approximate Miles of Sewers connected; Estimated Populations and Areas now contributing; Total Areas ultimately to contribute, and Present Populations on Such Areas; Ratios of Present Contributing Areas to Ultimate Areas, and Ratios of Populations now contributing to Present Total Populations.

(Population estimated as of December 31, 1918.)

CITIES AND TOWNS.	Miles of Local Sewers connected.	Separate or Combined.	Number of Connections with Local Sewers.	Estimated Number of Persons served by Each House Connection.	Estimated Population now contributing Sewage.	Estimated Present Total Population.	Estimated Area now contributing Sewage.	Area ultimately to contribute Sewage.	Ratio of Contributing Population to Present Total Population.	Ratio of Contributing Area to Ultimate Area.
							Sq. Miles.	Sq. Miles.	Per Cent.	Per Cent.
Boston (Back Bay),	26.54	Separate and combined,	1,866	21.30	39,750	40,100	1.15	1.61	99.1	71.4
Boston (Brighton),	63.38	Separate and combined,	4,017	10.10	40,570	43,580	3.20	3.74	93.1	85.6
Brookline,	74.82	Separate and combined,	4,955	7.45	36,910	37,330	3.65	6.81	98.9	53.6
Newton,	128.37	Separate,	7,633	5.50 ¹	41,980	45,650	7.85	16.88	92.0	46.5
Waltham,	47.60	Separate,	2,908	5.90	17,160	18,830	2.31	4.04	91.1	57.2
Waltham,	47.36	Separate,	3,902	7.70	30,050	32,060	2.44	13.63	93.7	17.9
Boston (Dorchester),	35.21	Separate and combined,	5,981	11.80	70,580	88,010	2.55	4.89	80.2	51.4
Milton,	17.55	Separate and combined,	962	5.00	4,810	9,350	0.97	12.59	89.3	35.2
Boston (Hyde Park),	34.51	Separate and combined,	2,427	7.40	17,960	20,120	1.61	9.40	40.1	9.3
Dedham,	17.40	Separate,	881	5.50	4,850	12,100 ²	0.87	1.23	—	—
Boston (Roxbury), ³	60.12	—	4,060	8.20	—	45,800	—	2.70	76.3	30.3
Boston (West Roxbury),	82.21	Separate and combined,	6,006	5.50	35,330 ⁴	46,290	2.70	8.92	—	—
Quincy,	—	Separate,	—	—	33,030	44,740	3.45	12.56	73.8	27.5
Wellesley, ⁵	—	—	—	—	—	7,210	—	9.89	—	—
Totals,	658.10	—	45,598	8.20	372,980	491,200	32.75	110.76	75.9	29.6

¹ Estimated from assessors' statement of the number of houses in the city or town on April 1, 1918, and the population from census of 1915.

² Part of town not included in Metropolitan Sewerage District.

³ At present connected with Boston Main Drainage System.

⁴ Including connection with institutions at Austin Farm, having an estimated population of 2,000.

⁵ Wellesley not yet connected with metropolitan sewer.

BOTH METROPOLITAN SEWERAGE SYSTEMS.

Table showing Areas delivering Sewage to both Systems; Approximate Miles of Sewers connected; Estimated Populations and Areas now contributing; Total Areas ultimately to contribute, and Present Populations on Such Areas; Ratios of Present Contributing Areas to Ultimate Areas, and Ratios of Populations now contributing to Present Total Populations.

[Population estimated as of December 31, 1918.]

SYSTEM.	Miles of Sewers connected.	Separate or Combined.	Number of Connections with Local Sewers.	Estimated Number of Persons served by Each House Connection.	Estimated Population now contributing Sewage.	Estimated Area now contributing Sewage.	Area ultimately to contribute Sewage.	Ratio of Contributing Population to Present Total Population.	Ratio of Contributing Area to Ultimate Area.
North Metropolitan,	774.30	Separate and combined,	84,773	6.8	570,440	Sq. Miles. 32.58	Sq. Miles. 100.32	Per Cent. 89.7	Per Cent. 32.5
South Metropolitan,	658.10	Separate and combined,	45,598	8.2	372,980	32.75	110.76	75.9	29.6
Totals,	1,432.40	- - -	130,371	7.3	952,420	65.33	211.08	83.7	31.0

PUMPING STATIONS.**CAPACITIES AND RESULTS.**

The following table shows the comparison of the growth in the amount of sewage handled and the cost of the same at the different stations in 1918 with the same items of 1917 and of 1914 when prices had not been affected by the war:—

PUMPING STATION.	SEWAGE PUMPED IN 1918 INCREASED OVER THAT OF—		COST OF PUMPING IN 1918 INCREASED OVER THAT OF—	
	1917.	1914.	1917.	1914.
	Per Cent.	Per Cent.	Per Cent.	Per Cent.
Deer Island,	3	13	17	48
East Boston,	3	14	33	48
Charlestown,	3	14	14	26
Alewife Brook,	11	7	11	37
Quincy,	4	6	20	44
Ward Street, . . . . .	.2 ¹	6	25	55

¹ Decrease.

Average Daily Volume of Sewage lifted at Each of the Six Principal Metropolitan Sewerage Pumping Stations and at the Quincy (Hough's Neck) Sewage Lifting Station during the Year, as compared with the Corresponding Volumes for the Previous Year.

PUMPING STATION.	AVERAGE DAILY PUMPAGE.			
	Jan. 1, 1917, to Dec. 31, 1917.	Jan. 1, 1918, to Dec. 31, 1918.	Increase during the Year.	
	Gallons.	Gallons.	Gallons.	Per Cent.
Deer Island,	64,600,000	66,500,000	1,900,000	2.9
East Boston,	62,600,000	64,500,000	1,900,000	3.0
Charlestown,	36,300,000	37,300,000	1,000,000	2.7
Alewife Brook,	3,393,000	3,767,000	374,000	11.0
Quincy,	4,033,000	4,218,000	185,000	4.5
Ward Street (actual gallons pumped), .	28,457,000	28,395,000	62,000 ¹	0.2 ¹
Quincy (Hough's Neck) sewage lifting station.	184,799	173,128	11,671 ¹	6.3 ¹

¹ Decrease.

NORTH METROPOLITAN SYSTEM.

Deer Island Pumping Station.

At this station are four submerged centrifugal pumps with impeller wheels 8.25 feet in diameter, driven by triple-expansion engines of the Reynolds-Corliss type.

Contract capacity of 1 pump: 100,000,000 gallons, with 19-foot lift.

Contract capacity of 3 pumps: 45,000,000 gallons each, with 19-foot lift.

Average duty for the year: 58,700,000 foot-pounds.

Average quantity raised each day: 66,500,000 gallons.

Force employed: 4 engineers, 1 relief engineer, 4 firemen, 4 oilers, 3 screenmen, 1 relief screenman and 1 laborer.

Coal used: Bituminous, costing from \$9.60 to \$11.80 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the Deer Island Pumping Station of the North Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1918.						
January,	2,097,100,000	67,600,000	54,900,000	87,400,000	8.80	55,700,000
February,	2,273,400,000	81,200,000	60,400,000	120,800,000	7.76	48,400,000
March,	2,316,900,000	74,700,000	53,400,000	119,600,000	9.22	56,600,000
April,	2,110,400,000	70,300,000	51,400,000	119,400,000	9.32	56,600,000
May,	2,020,100,000	65,200,000	51,400,000	94,400,000	9.45	61,500,000
June,	1,812,600,000	60,400,000	50,600,000	95,000,000	9.90	60,700,000
July,	1,859,100,000	60,000,000	48,900,000	83,500,000	9.40	60,300,000
August,	1,790,100,000	57,700,000	47,600,000	77,400,000	9.99	61,800,000
September,	2,125,800,000	70,900,000	47,100,000	126,900,000	10.41	63,200,000
October,	1,770,000,000	57,100,000	41,400,000	79,500,000	10.58	54,400,000
November,	1,856,600,000	61,900,000	51,700,000	97,800,000	10.92	60,900,000
December,	2,197,600,000	70,900,000	51,100,000	112,500,000	11.35	64,300,000
Total,	24,229,700,000	-	-	-	-	-
Average,	-	66,500,000	50,800,000	101,200,000	9.76	58,700,000

Average Cost per Million Foot-gallons for Pumping at the Deer Island Station.

Volume (24,229.7 Million Gallons) \times Lift (9.76 Feet) = 236,481.9 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot- gallons.
Labor,	\$19,157 33	\$0.08101
Coal,	24,525 00	0.10371
Oil,	289 47	0.00122
Waste,	131 95	0.00056
Water,	1,344 00	0.00568
Packing,	102 33	0.00043
Miscellaneous supplies, repairs and renewals,	799 03	0.00338
Totals,	\$46,349 11	\$0.19599
Labor at screens,	\$3,155 68	-

East Boston Pumping Station.

At this station are four submerged centrifugal pumps, with impeller wheels 8.25 feet in diameter, driven by triple-expansion engines of the Reynolds-Corliss type.

Contract capacity of 1 pump: 100,000,000 gallons, with 19-foot lift.

Contract capacity of 3 pumps: 45,000,000 gallons each, with 19-foot lift.

Average duty for the year: 68,200,000 foot-pounds.

Average quantity raised each day: 64,500,000 gallons.

Force employed: 4 engineers, 2 relief engineers, 3 firemen, 1 relief fireman, 4 oilers, 3 screenmen, 1 relief screenman, 3 helpers and 1 laborer.

Coal used: Bituminous, costing from \$5.65 to \$11.68 per gross ton, and anthracite screenings, costing \$6.04 to \$6.35 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the East Boston Pumping Station of the North Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1918.						
January,	2,035,100,000	65,600,000	52,900,000	85,400,000	14.13	62,600,000
February,	2,217,400,000	79,200,000	58,400,000	118,800,000	14.07	62,700,000
March,	2,254,900,000	72,700,000	51,400,000	117,600,000	14.17	61,500,000
April,	2,050,400,000	68,300,000	49,400,000	117,400,000	14.23	74,900,000
May,	1,958,100,000	63,200,000	49,400,000	92,400,000	14.11	63,800,000
June,	1,752,600,000	58,400,000	48,600,000	93,000,000	13.98	62,900,000
July,	1,797,100,000	58,000,000	46,900,000	81,500,000	14.17	71,800,000
August,	1,728,100,000	55,700,000	45,600,000	75,400,000	13.60	77,500,000
September,	2,065,800,000	68,900,000	45,100,000	124,900,000	13.77	67,700,000
October,	1,708,000,000	55,100,000	39,400,000	77,500,000	14.16	61,000,000
November,	1,796,600,000	59,900,000	49,700,000	95,800,000	14.61	79,400,000
December,	2,135,600,000	68,900,000	49,100,000	110,500,000	14.71	72,000,000
Total,	23,499,700,000	-	-	-	-	-
Average,	-	64,500,000	48,800,000	99,200,000	14.14	68,200,000

Average Cost per Million Foot-gallons for Pumping at the East Boston Station.

Volume (23,499.7 Million Gallons) \times Lift (14.14 feet) = 332,285.8 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot-gallons.
Labor,	\$23,013 39	\$0.06926
Coal,	30,700 00	0.09239
Oil,	709 51	0.00213
Waste,	56 27	0.00017
Water,	1,831 66	0.00551
Packing,	195 68	0.00059
Miscellaneous supplies, repairs and renewals,	1,142 60	0.00344
Totals,	\$57,649 11	\$0.17349
Labor at screens,	\$1,642 50	-

Charlestown Pumping Station.

At this station are three submerged centrifugal pumps, two of them having impeller wheels 7.5 feet in diameter, the other 8.25 feet in diameter. They are driven by triple-expansion engines of the Reynolds-Corliss type.

Contract capacity of 1 pump: 60,000,000 gallons, with 8-foot lift.

Contract capacity of 2 pumps: 22,000,000 gallons each, with 11-foot lift.

Average duty for the year: 46,400,000 foot-pounds.

Average quantity raised each day: 37,300,000 gallons.

Force employed: 4 engineers, 1 relief engineer, 4 firemen, 3 oilers, 3 screenmen and 1 relief screenman.

Coal used: Bituminous, costing from \$9.30 to \$12.43 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the Charlestown Pumping Station of the North Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1918.						
January,	1,187,600,000	38,300,000	30,800,000	66,300,000	6.01	57,200,000
February,	1,164,000,000	41,600,000	31,100,000	69,100,000	5.75	58,700,000
March,	1,180,600,000	38,100,000	30,500,000	67,400,000	5.56	45,700,000
April,	1,225,500,000	40,800,000	28,400,000	65,200,000	6.08	51,700,000
May,	1,153,100,000	37,200,000	31,600,000	50,200,000	6.21	44,300,000
June,	1,037,100,000	34,600,000	26,700,000	53,800,000	5.92	38,200,000
July,	1,022,900,000	33,000,000	25,200,000	44,800,000	6.64	42,800,000
August,	1,006,000,000	32,500,000	24,200,000	47,700,000	5.96	35,500,000
September,	1,160,500,000	38,700,000	25,000,000	57,900,000	6.02	41,200,000
October,	1,020,500,000	34,000,000	27,700,000	46,900,000	6.70	43,800,000
November,	1,069,800,000	35,700,000	27,700,000	58,500,000	7.06	47,000,000
December,	1,332,400,000	43,000,000	25,600,000	66,400,000	8.13	50,700,000
Total,	13,560,000,000	-	-	-	-	-
Average,	-	37,300,000	27,900,000	57,900,000	6.34	46,400,000

Average Cost per Million Foot-gallons for Pumping at the Charlestown Station.

Volume (13,560.0 Million Gallons) \times Lift (6.34 Feet) = 85,970.4 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot- gallons.
Labor,	\$16,026 61	\$0.18642
Coal,	10,200 00	0 11865
Oil,	287 39	0 00334
Waste,	20 59	0.00024
Water,	655 17	0 00762
Packing,	21 21	0 00025
Miscellaneous supplies, repairs and renewals,	316 56	0.00368
Totals,	\$27,527 53	\$0.32020
Labor at screens,	\$3,159 43	-

Alewife Brook Pumping Station.

The plant at this station consists of two 9-inch Andrews commercial centrifugal pumps, direct-connected by horizontal shafts to compound marine engines, together with a pump and engine added later. The latter consists of a specially designed engine of the vertical cross-compound type, having between the cylinders a centrifugal pump rotating on a horizontal axis.

Contract capacity of the 2 original pumps: 4,500,000 gallons each, with 13-foot lift.

Contract capacity of new pump: 13,000,000 gallons, with 13-foot lift.

Average duty for the year: 15,000,000 foot-pounds.

Average quantity raised each day: 3,767,000 gallons.

Force employed: 3 engineers, 1 relief engineer, 3 screenmen and 1 relief screenman.

Coal used: Bituminous, costing from \$8.40 to \$12.37 per gross ton, and anthracite screenings, costing \$5.30 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the Alewife Brook Pumping Station of the North Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1918.						
January,	91,835,000	2,962,000	2,456,000	5,559,000	13.10	10,600,000
February,	118,663,000	4,238,000	2,786,000	8,052,000	13.08	14,400,000
March,	163,763,000	5,283,000	4,201,000	8,229,000	13.04	17,900,000
April,	135,582,000	4,519,000	3,478,000	6,400,000	12.97	14,600,000
May,	117,208,000	3,781,000	3,028,000	6,076,000	13.07	16,600,000
June,	98,521,000	3,284,000	2,739,000	5,623,000	13.00	15,000,000
July,	94,434,000	3,046,000	2,550,000	3,862,000	13.01	14,000,000
August,	83,970,000	2,709,000	2,330,000	3,910,000	13.00	14,400,000
September,	118,464,000	3,949,000	2,372,000	7,167,000	12.97	16,400,000
October,	126,468,000	4,080,000	2,978,000	5,688,000	13.00	16,500,000
November,	91,374,000	3,046,000	2,598,000	5,106,000	13.00	13,700,000
December,	133,405,000	4,303,000	2,692,000	6,754,000	13.10	15,300,000
Total,	1,373,687,000	—	—	—	—	—
Average,	—	3,767,000	2,851,000	6,036,000	13.03	15,000,000

Average Cost per Million Foot-gallons for Pumping at the Alewife Brook Station.

Volume (1,373.687 Million Gallons) \times Lift (13.03 Feet) = 17,899.14 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot-gallons.
Labor,	\$5,751 18	\$0.32131
Coal,	5,760 00	0.32180
Oil,	212 01	0.01185
Waste,	90 08	0.00503
Water,	229 44	0.01282
Packing,	5 19	0.00029
Miscellaneous supplies, repairs and renewals,	101 63	0.00568
Totals,	\$12,149 53	\$0.67878
Labor at screens, oiling and miscellaneous services,	\$3,428 04	—

SOUTH METROPOLITAN SYSTEM.

Ward Street Pumping Station.

At this station are two vertical, triple-expansion pumping engines, of the Allis-Chalmers type, operating reciprocating pumps, the plungers of which are 48 inches in diameter with a 60-inch stroke.

Contract capacity of 2 pumps: 50,000,000 gallons each, with 45-foot lift.

Average duty for the year: 78,932,000 foot pounds.

Average quantity raised each day: 28,395,000 gallons.

Force employed: 4 engineers, 1 relief engineer, 4 firemen, 5 oilers, 4 assistant engineers, 1 machinist and 1 laborer.

Coal used: Bituminous, costing from \$9.25 to \$13.22 per gross ton, and anthracite screenings, costing \$7.56 to \$7.90 per gross ton.

Material intercepted at screens during the year: 1,474.7 cubic yards.

Table of Approximate Quantities, Lifts and Duties at the Ward Street Pumping Station of the South Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft. lbs. per 100 lbs. Coal).
1918.						
January,	817,551,000	26,373,000	23,612,000	36,343,000	39.79	69,646,000
February,	859,142,000	30,684,000	24,400,000	43,508,000	40.03	69,408,000
March,	1,048,941,000	33,837,000	25,761,000	54,459,000	40.73	74,100,000
April,	947,860,000	31,595,000	25,066,000	45,170,000	41.09	79,553,000
May,	971,901,000	31,351,000	24,764,000	41,861,000	41.31	90,248,000
June,	755,477,000	25,183,000	22,374,000	39,646,000	40.80	82,684,000
July,	770,294,000	24,848,000	21,133,000	30,753,000	40.38	76,890,000
August,	692,279,000	22,332,000	19,555,000	27,625,000	40.06	76,754,000
September,	896,278,000	29,876,000	19,666,000	49,751,000	40.46	88,680,000
October,	900,896,000	29,061,000	26,658,000	34,724,000	40.49	83,226,000
November,	777,512,000	25,917,000	22,985,000	34,948,000	40.28	72,900,000
December,	920,268,000	29,686,000	22,374,000	39,098,000	40.55	83,089,000
Total,	10,358,399,000	-	-	-	-	-
Average,	-	28,395,000	23,196,000	39,824,000	40.50	78,932,000

Records from plunger displacements.

Average Cost per Million Foot-gallons for Pumping at the Ward Street Station.

Volume (10,358.399 Million Gallons) \times Lift (40.50) = 419,515.16 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot- gallons.
Labor,	\$18,185 86	\$0.04335
Coal,	27,690 15	0.06601
Oil,	302 58	0.00072
Waste,	-	-
Water,	1,677 60	0.00400
Packing,	463 64	0.00111
Miscellaneous supplies, repairs and renewals,	3,373 71	0.00804
Totals,	\$51,693 54	\$0.12323
Labor at screens,	\$4,827 16	-

Quincy Pumping Station.

At this station are two compound condensing Deane pumping engines and one Lawrence centrifugal pump driven by a Sturtevant compound condensing engine.

Contract capacity of 3 pumps: Deane, 3,000,000 gallons; Deane, 5,000,000 gallons; Lawrence centrifugal, 10,000,000 gallons.

Average duty for the year: 29,600,000 foot-pounds.

Average quantity raised each day: 4,218,000 gallons.

Force employed: 3 engineers, 1 relief engineer, 3 screenmen and 1 relief screenman.

Coal used: Bituminous, costing \$7.92 to \$13.22 per gross ton, and anthracite screenings, costing \$6 per gross ton.

Materials intercepted at screen during the year: 309 cubic yards.

Table of Approximate Quantities, Lifts and Duties at the Quincy Pumping Station of the South Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1918.						
January,	120,025,000	3,872,000	3,235,000	5,648,000	21.48	24,400,000
February,	125,477,000	4,481,000	3,334,000	9,899,000	23.26	28,500,000
March,	167,318,000	5,397,000	4,226,000	6,709,000	26.91	32,200,000
April,	174,080,000	5,803,000	4,216,000	12,598,000	24.18	30,800,000
May,	154,222,000	4,975,000	3,930,000	6,809,000	22.19	28,300,000
June,	110,003,000	3,667,000	3,234,000	4,100,000	21.03	27,800,000
July,	109,921,000	3,546,000	2,968,000	4,974,000	20.99	26,900,000
August,	98,139,000	3,166,000	2,843,000	3,619,000	20.84	31,300,000
September,	111,252,000	3,708,000	2,109,000	6,186,000	21.82	32,500,000
October,	126,084,000	4,067,000	3,623,000	4,808,000	21.79	31,100,000
November,	107,536,000	3,585,000	3,283,000	4,282,000	21.01	30,600,000
December,	134,931,000	4,353,000	3,360,000	5,280,000	22.77	31,200,000
Total,	1,538,988,000	-	-	-	-	-
Average,	-	4,218,000	3,363,000	6,243,000	22.36	29,600,000

Average Cost per Million Foot-gallons for Pumping at the Quincy Station.

Volume (1,538.988 Million Gallons) \times Lift (22.36) = 34,411.77 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot-gallons.
Labor,	\$6,082 15	\$0.17675
Coal,	5,667 48	0.16470
Oil,	61 40	0.00178
Waste,	19 29	0.00056
Water,	267 32	0.00777
Packing,	6 62	0.00019
Miscellaneous supplies, repairs and renewals,	271 69	0.00789
Totals,	\$12,375 95	\$0.35964
Labor at screens, oiling and miscellaneous services,	\$3,543 06	-

Nut Island Screen-house.

The plant at this house includes two sets of screens in duplicate actuated by small reversing engines of the Fitchburg type. Two vertical Dean boilers, 80 horse power each, operate the engines, provide heat and light for the house, burn materials intercepted at the screens, and furnish power for the Quincy (Hough's Neck) sewage lifting station.

Average daily quantity of sewage passing screens: 56,200,000 gallons.

Total materials intercepted at screens: 709.9 cubic yards.

Materials intercepted per million gallons of sewage discharged: 0.93 cubic feet.

Force employed: 3 engineers, 1 relief engineer, 3 screenmen and 1 relief screenman.

Coal used: Bituminous, costing \$10.55 per gross ton.

Quincy (Hough's Neck) Sewage Lifting Station.

At this station are two 6-inch submerged Lawrence centrifugal pumps with vertical shafts actuated by two Sturtevant direct-current motors.

The labor and electric energy for this station are supplied from the Nut Island screen-house and as used at present it does not materially increase the amount of coal used at the latter station. The effluent is largely ground water.

Contract capacity of 2 pumps: about 1,500,000 gallons each, with 20-foot lift.

Average daily amount pumped: 173,128 gallons.

Average lift: 15.31 feet.

Coal delivered in the Bins of the Sewerage Works Pumping Stations during the Year.

	GROSS TONS, BITUMINOUS COAL.							Price per Gross Ton.
	Deer Island Pumping Station.	East Boston Pumping Station.	Charlestown Pumping Station.	Alewife Brook Pumping Station.	Ward Street Pumping Station.	Quincy Pumping Station.	Nut Island Screen-house.	
C. H. Sprague & Son,	504	-	-	-	-	-	-	\$11 80
Maritime Coaling Co.,	500	-	-	-	-	-	-	9 91
Maritime Coaling Co.,	500	-	-	-	-	-	-	10 25
Maritime Coaling Co.,	1,160	-	-	-	-	-	-	10 90
N. E. Coal & Coke Co.,	-	112	-	-	-	-	-	5 65
Staples Coal Co.,	-	31	-	-	-	-	-	7 11
Coastwise Coal Co.,	-	7	-	-	-	-	-	9 30
Maritime Coaling Co.,	-	326	-	-	-	-	-	10 07
Maritime Coaling Co.,	-	500	-	-	-	-	-	10 14
Maritime Coaling Co.,	-	378	-	-	-	-	-	10 55
Maritime Coaling Co.,	-	485	-	-	-	-	-	11 08
Maritime Coaling Co.,	-	513	-	-	-	-	-	11 48
Castner, Curran & Bullitt,	-	351	-	-	-	-	-	11 57
N. E. Coal & Coke Co.,	-	251	-	-	-	-	-	11 68
Coastwise Coal Co.,	-	-	15	-	-	-	-	9 30
Maritime Coaling Co.,	-	-	290	-	-	-	-	10 25
N. E. Coal & Coke Co.,	-	-	103	-	-	-	-	12 43
Maritime Coaling Co.,	-	-	263	-	-	-	-	11 48
Maritime Coaling Co.,	-	-	20	-	-	-	-	11 53
Castner, Curran & Bullitt,	-	-	217	-	-	-	-	11 56
Locke Coal Co.,	-	-	-	9	-	-	-	5 30
Gorman-Leonard Coal Co.,	-	-	-	48	-	-	-	8 40
Locke Coal Co.,	-	-	-	10	-	-	-	9 85
Locke Coal Co.,	-	-	-	394	-	-	-	11 50
Castner, Curran & Bullitt,	-	-	-	23	-	-	-	11 88
Locke Coal Co.,	-	-	-	50	-	-	-	12 37
Batchelder Bros.,	-	-	-	-	7	-	-	10 40
Staples Coal Co.,	-	-	-	-	1	-	-	7 05
Staples Coal Co.,	-	-	-	-	14	-	-	7 60
Staples Coal Co.,	-	-	-	-	7	-	-	9 25
Staples Coal Co.,	-	-	-	-	97	-	-	10 50
C. H. Sprague & Son,	-	-	-	-	198	-	-	10 62

Coal delivered in the Bins of the Sewerage Works Pumping Stations during the Year
— Concluded.

	GROSS TONS, BITUMINOUS COAL.							Price per Gross Ton.
	Deer Island Pumping Station.	East Boston Pumping Station.	Charlestown Pumping Station.	Alewife Brook Pumping Station.	Ward Street Pumping Station.	Quincy Pumping Station.	Nut Island Screening-house.	
Batchelder Bros.,	-	-	-	-	13	-	-	\$10 73
Staples Coal Co.,	-	-	-	-	183	-	-	11 25
Staples Coal Co.,	-	-	-	-	2,312	-	-	11 50
Staples Coal Co.,	-	-	-	-	97	-	-	13 22
E. Russell Norton,	-	-	-	-	-	41	-	7 92
E. Russell Norton,	-	-	-	-	-	28	-	7 97
E. Russell Norton,	-	-	-	-	-	42	-	8 34
E. Russell Norton,	-	-	-	-	-	246	-	8 45
E. Russell Norton,	-	-	-	-	-	47	-	8 55
City Fuel Co.,	-	-	-	-	-	47	-	11 50
Staples Coal Co.,	-	-	-	-	-	119	-	11 50
J. F. Sheppard & Sons, Inc.,	-	-	-	-	-	24	-	13 22
Maritime Coaling Co.,	-	-	-	-	-	-	400	10 55
Total, bituminous,	2,664	2,923	908	525	2,914	594	400	-
Total, screenings,	-	31	-	9	15	-	-	-
Average cost, bituminous,	\$10 76	\$10 74	\$11 18	\$11 31	\$11 51	\$9 54	\$10 55	-
Average cost, screenings,	-	\$7 11	-	\$5 30	\$7 74	-	-	-

METROPOLITAN SEWERAGE OUTFALLS.

The extension of the Deer Island outfall was fully described in last year's report. It has been in operation during the year and the condition of the harbor water at this point is very much improved. Except at the slack periods of the tide at high and low water it is difficult to detect the presence of sewage in this locality.

The 60-inch outfalls of the South Metropolitan System, two of which were completed in 1904 and the third one in 1915, are in good condition and free from deposit.

During the year the average flow through the North Metropolitan outfall at Deer Island has been 66,500,000 gallons of sewage per 24 hours, with a maximum rate of 163,000,000 gallons during a stormy

period in February, 1918. The amount of sewage discharged in the North Metropolitan District averaged 115 gallons per day for each person, taking the estimated population of the district contributing sewage. If the sewers in this district were restricted to the admission of sewage proper only, this per capita amount would be considerably decreased.

In the South Metropolitan District an average of 56,200,000 gallons of sewage has passed daily through the screens at the Nut Island screen-house, and has been discharged from the outfalls into the outer harbor. The maximum rate of discharge per day, which occurred during a heavy storm on June 12, 1918, was 152,500,000 gallons. The discharge of sewage through these outfalls represents the amount of sewage contributed in the South Metropolitan System, which was at the rate of 151 gallons per day per person of the estimated number contributing sewage in the district.

The daily discharge of sewage per capita is considerably larger in the South Metropolitan District than it is in the North Metropolitan District, because, owing to the large size and unused capacity of the High-level Sewer, more storm water is at present admitted to the sewers.

Material Intercepted at the Screens.

The material intercepted at the screens at the North Metropolitan Sewerage stations, consisting of rags, paper and other floating materials, has during the year amounted to 1,742.8 cubic yards. This is equivalent to 1.942 cubic feet for each million gallons of sewage pumped at Deer Island.

The material intercepted at the screens at the South Metropolitan Sewerage stations has amounted to 2,493.6 cubic yards, equal to 3.28 cubic feet per million gallons of sewage delivered at the outfall works at Nut Island.

Studies of sewage flows in the Metropolitan sewers and siphons indicate that they are free from deposit.

FREDERICK D. SMITH,
Chief Engineer of Sewerage Works.

BOSTON, January 1, 1919.

APPENDIX.

APPENDIX No. 1.

CONTRACTS MADE AND PENDING DURING

[NOTE. — The details of contracts made before

1.	2.	3.	AMOUNT OF BID.		6.	
			4.	5.		
Number of Contract.	WORK.	Number of Bids.	Next to Lowest.	Lowest.	Contractor.	
1	382 ¹	Centrifugal pumping unit for Northern Extra High Service pumping station, Arlington.	3	\$10,655 00	\$9,000 00 ²	F. A. Mazzur & Co., Boston.
2	383 ¹	Horizontal fire-tube boiler for Northern Extra High Service pumping station, Arlington.	3	2,369 00	2,296 00 ²	New England Iron Works Co., Boston.
3	385 ¹	Electric power transmission line between Wachusett power station in Clinton and Sudbury power station in Southborough.	3	79,000 00	74,477 00 ²	Fred T. Ley & Co., Springfield, Mass.
4	386 ¹	Furnishing steel work for extension of coal pocket at the Northern Extra High Service pumping station, Arlington.	3	672 00	620 00 ²	Builders Iron & Steel Co., Cambridge, Mass.
5	387 ¹	Laying 20-inch water pipes in Boston and Newton.	8	30,465 00 ²	30,455 00	Michele De Sisto, West Roxbury, Mass.
6	388 ¹	940 tons 20-inch cast-iron water pipe; 12 tons special castings.	2	52,080 00	51,772 50 ²	United States Cast Iron Pipe & Foundry Co., Philadelphia, Pa.
7	389 ¹	36,300 pounds 12-inch flexible-jointed cast-iron water pipe; 1,572 pounds special castings.	1	-	2,196 68 ²	United States Cast Iron Pipe & Foundry Co., Philadelphia, Pa.
8	390 ¹	Furnishing and laying granite and seam face masonry for extension of coal pocket at Northern Extra High Service pumping station, Arlington.	5	1,295 00	1,119 00 ²	F. C. Alexander, Boston.

¹ Contract completed.

APPENDIX No. 1.

THE YEAR 1918 — WATER WORKS.

1918 have been given in previous reports.]

7. Date of Con- tract.	8. Date of Completion of Contract.	9. Prices of Principal Items of Contracts.	10. Value of Work done Dec. 31, 1918.	
Mar. 31, 1917	June 6, 1918	See previous report,	\$9,700 00	1
May 15, 1917	July 15, 1918	See previous report,	2,324 51	2
July 28, 1917	July 24, 1918	See previous report,	74,875 14	3
Jan. 29, 1918	May 4, 1918	For whole work, \$620,	620 00	4
May 29, 1918	Nov. 1, 1918	For laying 20-inch cast-iron pipe, \$2.75 per lin. ft.; for laying 6-inch and 16-inch cast-iron pipe for blow-offs and connections, \$2 per lin. ft.; for rock excavation above regular grade of bottom of trench, \$6.50 per cu. yd.; for rock excavation below regular grade of bottom of trench, \$8 per cu. yd.; for earth excavation below regular grade of bottom of trench, \$2 per cu. yd.; for chambers for 20-inch valves, \$60 each, for 16-inch and smaller valves, \$40 each; for concrete masonry, \$10 per cu. yd.	31,330 21	5
May 1, 1918	Nov. 27, 1918	For pipes, \$53.70 per ton of 2,000 pounds, for special castings, \$106.60 and \$126.60 per ton of 2,000 pounds, all f. o. b. foundry.	51,701 97	6
June 26, 1918	Dec. 4, 1918	For flexible jointed pipe, 6 cents per pound; for special castings, 9.5 cents per pound, all less \$6.90 per ton of 2,000 pounds allowed for freight.	2,221 37	7
July 12, 1918	Oct. 1, 1918	For whole work, \$1,119,	1,119 00	8

² Contract based upon this bid.

CONTRACTS MADE AND PENDING DURING

	1. Number of Contract.	2. WORK.	3. Number of Bids.	AMOUNT OF BID.		6. Contractor.
				4. Next to Lowest.	5. Lowest.	
9	39-M	Sale and purchase of electric energy to be developed at Sudbury Dam in Southborough.	2	- ³	- ³	Edison Electric Illuminating Co. of Boston.
10	51-M	Sale and purchase of electric energy to be developed at Wachusett Dam in Clinton.	1	-	\$5.30 per M kilowatt hours.	New England Power Co. and Edison Electric Illuminating Co. of Boston.
11	52-M ¹	2,000 tons anthracite screenings for Chestnut Hill pumping stations, 240 tons for Arlington pumping station.	Chestnut Hill stations, 2. Arlington station, 2.	\$5.15 per ton, subject to change in freight rate. \$6 per ton, subject to change in freight rate.	\$4.20 ² per ton, subject to change in freight rate. \$4.65 ² per ton, subject to change in freight rate.	Dexter & Carpenter, Inc., Boston.
12	53-M ¹	400 tons anthracite screenings for Spot Pond pumping station.	1	-	\$5.30 per ton, subject to change in freight rate.	Locke Coal Co., Malden, Mass.
13	54-M ¹	4,000 tons bituminous coal for Chestnut Hill pumping stations, 400 tons for Arlington pumping station.	Chestnut Hill stations, 2. Arlington station, 1.	\$8.35 per ton, subject to change in freight rate. -	\$7.35 ² per ton, subject to change in freight rate. \$7.80 ² per ton, subject to change in freight rate.	Shaftsbury Coal and Coke Co., Inc., New York, N. Y.
14	55-M ¹	800 tons bituminous coal for Spot Pond pumping station.	2	\$11 per ton, delivered at station.	\$8.70 ² per ton, subject to change in freight rate or in mining wage scale, f. o. b. cars, Melrose.	E. Russell Norton, Boston.
15	56-M ¹	Venturi meter tube, register and chart recorder.	- ⁵	- ⁵	- ⁵	Builders Iron Foundry, Providence, R. I.
16	59-M ¹	Ash conveyor for Spot Pond pumping station.	2	1,250 00	609 00 ²	George J. Hagan Co., Boston.
17	61-M ¹	Furnishing two electrically operated head gate hoists.	1	-	800 00 ²	Union Gear and Machine Co., Boston.

¹ Contract completed.² Contract based upon this bid.

THE YEAR 1918 — WATER WORKS — *Continued.*

7. Date of Con- tract.	8. Date of Completion of Contract.	9. Prices of Principal Items of Contracts.	10. Value of Work done Dec. 31, 1918.	
Dec. 21, 1914	Jan. 1, 1922	About 5,000,000 kilowatt hours of energy per year at \$6.25 per thousand kilowatt hours,	\$66,817 86	9
Jan. 13, 1917	Jan. 1, 1929	About 7,000,000 kilowatt hours of energy per year at \$5.30 per thousand kilowatt hours,	- ⁴	10
June 4, 1917	Feb. 4, 1918	See previous report,	9,930 70	11
June 6, 1917	Jan. 22, 1918	See previous report,	2,304 87	12
July 9, 1917	June 8, 1918	See previous report,	27,420 85	13
May 28, 1917	April 16, 1918	See previous report,	6,701 51	14
Sept. 26, 1917	Jan. 25, 1918	See previous report,	725 00	15
Oct. 19, 1917	June 20, 1918	See previous report,	609 00	16
Mar. 4, 1918	June 14, 1918	For whole work, \$800,	800 00	17

³ Contract based upon bid of \$6.25 per thousand kilowatt hours for entire output. Other bid for portion of output.

⁴ Delivery of energy to begin Jan. 1, 1919.

⁵ Competitive bids were not received.

CONTRACTS MADE AND PENDING DURING

	1. Number of Contract.	2. WORK.	3. Num- ber of Bids.	AMOUNT OF BID.		6. Contractor.
				4. Next to Lowest.	5. Lowest.	
18	62-M	3,000 tons anthracite screen- ings.	-	-	-	Dexter & Carpenter, Inc., Boston.
19	63-M	6,000 tons bituminous coal, .	-	-	-	E. Russell Norton, Boston.
20	Agree- ment. ¹	Sale and purchase of electric energy to be developed at Wachusett Dam after expira- tion of Contract No. 22-M and until energy is delivered under Contract No. 51-M after completion of trans- mission line under Contract No. 385.	- ⁶	- ⁶	- ⁶	New England Power Co., Boston.
21	Agree- ment. ¹	Furnishing head gates for Wachusett Aqueduct.	4	\$299 00	\$250 00 ²	A. T. Stearns Lumber Co., Boston.
22	Agree- ment. ¹	Heat insulation of steam pipes and boilers at northern extra high service pumping sta- tion.	2	328 00	279 00 ²	Nightingale & Childs Co., Boston.

¹ Contract completed.² Contract based upon this bid.

THE YEAR 1918 — WATER WORKS — *Continued.*

7. Date of Con- tract.	8. Date of Completion of Contract.	9. Prices of Principal Items of Contracts.	10. Value of Work done Dec. 31, 1918.	
May 13, 1918	-	For anthracite screenings, \$2.25 per ton of 2,240 pounds f. o. b. mine.	\$4,594 45	18
May 17, 1918	-	For bituminous coal the United States Fuel Administration's prices and purchasing commission at time of shipment — Contractor to act as Agent for the Board.	12,723 22	19
Oct. 1, 1916	Dec. 31, 1918	See previous report,	88,948 54	20
Feb. 19, 1918	Mar. 22, 1918	For whole work, \$250,	246 75	21
Aug. 24, 1918	Oct. 15, 1918	For whole work, \$279,	279 00	22

⁶ Agreement made with New England Power Company with which the Connecticut River Transmission Company, the contractor under Contract No. 22-M, was consolidated.

CONTRACTS MADE AND PENDING DURING THE YEAR 1918 — WATER WORKS —
Concluded.

Summary of Contracts 1895 to 1918, inclusive. ¹

	Value of Work done Dec. 31, 1918.
Distribution Department, 7 contracts,	\$99,017 06
Wachusett Department, 1 contract,	74,875 14
388 contracts completed from 1896 to 1917, inclusive,	17,399,274 51
	<hr/> \$17,573,166 71
Deduct for work done on 11 Sudbury Reservoir contracts by the city of Boston, .	512,000 00
Total of 396 contracts,	<hr/> \$17,061,166 71

¹ In this summary contracts charged to maintenance are excluded.

APPENDIX No. 2.

TABLE No. 1. — *Monthly Rainfall in Inches at Various Places on the Metropolitan Water Works, in 1918.*

PLACE.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
Princeton,	2.42	3.27	1.66	3.33	1.16	4.33	2.29	2.75	6.39	1.46	2.82	3.54	35.42
Jefferson,	3.25	5.27	3.07	3.58	0.86	4.73	2.67	3.65	6.61	2.05	3.47	4.08	42.69
Sterling,	2.67	4.51	1.97	3.15	1.17	3.96	2.13	3.02	6.94	1.26	3.25	3.86	37.89
Boylston,	3.52	3.97	2.26	3.82	1.07	5.25	4.12	2.45	8.80	1.55	2.80	3.47	43.08
Sudbury Dam,	3.49	3.50	2.38	4.10	1.06	3.64	3.82	1.73	8.07	0.97	2.80	3.46	39.02
Framingham,	3.34	3.72	2.43	4.53	1.03	3.57	4.06	1.44	8.29	1.01	2.59	3.73	39.77
Ashland Dam,	3.30	3.35	2.54	4.34	1.28	3.26	4.28	1.55	8.70	1.04	2.40	3.66	39.70
Cordaville,	3.76	3.76	2.63	4.74	1.25	4.13	4.13	1.71	9.36	1.12	3.19	3.87	43.65
Lake Cochituate,	3.26	3.80	2.26	4.61	1.10	3.34	3.61	1.41	8.58	0.92	2.57	3.55	39.04
Chestnut Hill Reservoir,	3.46	4.04	1.98	4.50	1.17	2.40	3.93	1.68	9.34	1.25	1.88	4.18	39.81
Spot Pond,	3.56	3.51	2.46	4.31	1.37	2.67	3.63	2.18	9.42	1.13	2.05	4.07	40.36
Average of all,	3.26	3.88	2.33	4.09	1.14	3.75	3.52	2.09	8.23	1.25	2.71	3.77	40.02
Average, Wachusett watershed,	2.97	4.25	2.24	3.47	1.07	4.57	2.80	2.82	7.18	1.58	3.08	3.74	39.77
Average, Sudbury watershed,	3.47	3.58	2.50	4.43	1.16	3.65	4.07	1.61	8.60	1.04	2.75	3.68	40.54

TABLE NO. 2. — *Rainfall in Inches at Jefferson, Mass., in 1918.*

DAY OF MONTH.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1,	-	-	0.06	-	-	-	0.23	-	-	-	-	-
2,	-	-	-	-	-	-	-	-	-	-	-	-
3,	-	0.07 ¹	-	0.12	-	-	-	-	-	0.63	-	-
4,	-	-	0.36 ¹	-	-	-	0.12	0.15	-	-	2	-
5,	-	-	-	-	-	-	-	-	-	-	0.28	-
6,	2	0.50 ¹	0.20	-	-	0.28	-	-	-	0.64	-	0.60 ¹
7,	0.42 ³	-	0.68 ¹	-	-	0.76	0.06	-	-	0.12	-	-
8,	-	-	-	-	-	-	-	-	0.52	-	-	0.07
9,	-	0.65 ³	2	0.08	-	-	-	0.78	-	-	2	-
10,	-	0.04 ¹	1.38 ³	-	-	0.09	-	-	-	-	0.60	-
11,	-	-	-	2	-	-	0.09	0.27	-	-	-	2
12,	1.21 ³	-	0.08 ³	2	-	0.78	0.10	-	2	-	-	0.78 ³
13,	-	-	-	1.12 ³	-	-	-	-	1.12	-	-	2
14,	-	-	0.31 ³	-	0.26	0.41	0.19	0.98	-	-	-	2
15,	1.11 ³	0.31	-	-	-	-	-	-	-	-	-	0.99
16,	-	-	-	-	-	-	-	-	-	-	-	-
17,	-	0.06 ¹	-	-	-	-	0.72	-	0.36	-	2	-
18,	-	-	-	0.22 ³	-	-	-	-	0.67	-	2.09	-
19,	0.23 ¹	2	-	-	-	-	-	-	-	-	0.07	-
20,	-	1.51	-	-	-	-	-	-	2	2	-	-
21,	-	-	-	0.98	0.09	2	-	-	1.66	0.34	-	-
22,	0.12 ¹	0.19 ¹	-	-	-	2.28	-	-	-	-	-	0.42
23,	-	-	-	0.14	-	0.13	-	-	-	-	-	-
24,	-	-	-	-	-	-	-	-	0.08	-	-	2
25,	0.07 ¹	2	-	-	0.24	-	-	-	-	-	-	0.65
26,	-	0.78	-	-	-	-	-	0.08	2.20	-	-	2
27,	-	-	-	-	-	-	-	-	-	-	-	0.09 ¹
28,	2	1.16 ³	-	-	-	-	-	-	-	-	0.31	-
29,	0.09 ¹	-	-	0.06	2	-	-	0.37	-	-	-	-
30,	-	-	-	2	0.27	-	2	-	-	2	2	-
31,	-	-	-	0.86	-	-	1.16	0.42	-	0.32	0.12	0.48 ³
Totals,	3.25	5.27	3.07	3.58	0.86	4.73	2.67	3.05	6.61	2.05	3.47	4.08

Total for the year, 42.69 inches.

¹ Snow.² Rainfall included in that of following day.³ Rain and snow.

TABLE NO. 3. — *Rainfall in Inches at Framingham, Mass., in 1918.*

DAY OF MONTH.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1,	-	-	0.13 ¹	-	0.08	-	²	-	-	-	-	-
2,	-	-	-	-	-	-	0.04	-	-	²	-	²
3,	0.02 ¹	0.15 ¹	-	0.20	-	-	-	-	-	0.09	-	²
4,	-	-	²	-	-	-	0.03	-	-	-	²	0.13 ³
5,	-	-	0.19 ¹	-	-	-	²	0.16	-	-	0.35	-
6,	-	²	0.11	-	-	0.07	0.13	-	-	0.13	-	0.63 ¹
7,	²	0.03 ¹	0.45 ¹	-	0.08	0.50	1.06	0.06	-	-	-	-
8,	0.74 ³	-	-	-	0.06	-	-	-	²	-	-	-
9,	-	0.28 ³	²	0.03	-	-	-	0.44	0.82	-	²	-
10,	-	0.04 ¹	1.17 ³	-	-	0.05	0.38	-	-	-	0.16	-
11,	-	-	-	-	-	-	0.24	0.16	-	-	-	²
12,	1.13 ³	-	0.03	²	-	0.24	-	-	²	0.11	-	0.95 ³
13,	-	-	-	²	²	-	-	-	1.79	0.03	0.07	²
14,	²	-	0.35 ³	1.41 ³	0.29	0.02	-	0.26	-	-	-	²
15,	0.99 ³	0.08	-	-	-	-	-	-	-	-	-	0.67
16,	-	²	-	-	-	-	-	-	-	0.01	-	-
17,	-	0.14 ¹	-	²	-	-	0.75	-	-	-	²	-
18,	-	-	-	0.28	-	-	-	-	1.16	-	1.64	-
19,	0.09 ¹	²	-	-	-	0.07	-	-	-	-	-	-
20,	-	0.71	-	²	-	-	0.06	-	²	²	0.07	-
21,	-	-	-	1.28	²	²	-	-	1.60	0.17	-	-
22,	0.16 ¹	0.15 ¹	-	-	0.14	2.43	-	-	-	-	-	0.29
23,	-	-	-	0.07	-	0.19	-	-	-	-	-	-
24,	-	-	-	-	-	-	-	0.01	0.07	-	-	²
25,	0.02 ¹	²	-	-	0.17	-	0.02	-	-	-	-	0.70
26,	-	1.04	-	-	-	-	-	0.03	²	0.02	-	-
27,	-	-	-	-	0.05	-	-	-	2.73	-	-	-
28,	²	1.10 ³	-	-	-	-	-	-	-	-	²	-
29,	0.19 ¹	-	-	²	-	-	-	0.13	-	-	0.27	0.01 ¹
30,	-	-	-	1.26	0.16	-	²	-	0.12	-	0.03 ¹	-
31,	-	-	-	-	-	-	1.35	0.19	-	0.48	-	0.35 ³
Totals,	3.34	3.72	2.43	4.53	1.03	3.57	4.06	1.44	8.29	1.04	2.59	3.73

Total for the year, 39.77 inches.

¹ Snow.² Rainfall included in that of following day.³ Rain and snow.

TABLE NO. 4. — *Rainfall in Inches at Chestnut Hill Reservoir, 1918.*

DATE.	Amount.	Duration.	DATE.	Amount.	Duration.
Jan. 7, . . . . .	.76 ²	5.00 A.M. to 7.30 A.M.	May 1, . . . . .	.04	7.30 A.M. to 9.00 A.M.
Jan. 8, . . . . .	.66 ²	1.15 A.M. to 4.45 A.M.	May 6, . . . . .	.04	4.00 P.M. to 4.30 P.M.
Jan. 12, . . . . .	.25	4.45 A.M. to 9.45 A.M.	May 7, . . . . .	.05	1.15 A.M. to 2.00 A.M.
Jan. 12, . . . . .	.55 ¹	1.15 A.M. to 9.45 A.M.	May 8, . . . . .	.06	10.00 A.M. to 10.30 A.M.
Jan. 15, . . . . .	.44	9.45 A.M. to 12.45 P.M.	May 14, . . . . .	.19	6.30 A.M. to 3.00 P.M.
Jan. 15, . . . . .	.04 ¹	4.15 A.M. to 6.40 A.M.	May 22, . . . . .	.20	12.15 A.M. to 6.45 A.M.
Jan. 17, . . . . .	.13 ¹	1.15 A.M. to 9.30 A.M.	May 25, . . . . .	.17	8.05 P.M. to 2.15 A.M.
Jan. 19, . . . . .	.05 ¹	12.10 P.M. to 2.35 P.M.	May 27, . . . . .	.15	7.00 A.M. to 9.00 A.M.
Jan. 19, . . . . .	.20 ¹	12.00 M. to 7.00 P.M.	May 28, . . . . .	.17	3.45 P.M. to 7.30 P.M.
Jan. 22, . . . . .	.05 ¹	4.15 A.M. to 12.15 P.M.	May 29, . . . . .	.10	6.10 P.M. to 3.00 A.M.
Jan. 25, . . . . .	.34	11.30 A.M. to 7.00 A.M.	May 30,		
Jan. 29,			Total,	1.17	
Total,	3.46				
Feb. 3, . . . . .	.16 ¹	10.00 A.M. to 10.30 P.M.	June 6, . . . . .	.05	3.15 P.M. to 6.30 P.M.
Feb. 6, . . . . .	.04 ¹	6.20 P.M. to 11.00 P.M.	June 7, . . . . .	.33	9.00 A.M. to 3.00 P.M.
Feb. 9, . . . . .	.36 ¹	9.00 A.M. to 3.30 P.M.	June 9, . . . . .	.08	5.15 A.M. to 10.00 A.M.
Feb. 10, . . . . .	.08 ¹	9.00 A.M. to 7.00 P.M.	June 10, . . . . .	.16	7.30 A.M. to 9.00 P.M.
Feb. 15, . . . . .	.15	12.30 A.M. to 8.45 A.M.	June 12, . . . . .	.04	4.15 P.M. to 9.00 P.M.
Feb. 16, . . . . .	.16 ¹	10.10 P.M. to 9.00 A.M.	June 14, . . . . .	.03	8.40 P.M. to 10.45 P.M.
Feb. 17, . . . . .	.62	2.45 P.M. to 7.30 A.M.	June 21,	1.67	11.00 P.M. to 3.05 P.M.
Feb. 19, . . . . .	.16 ¹	3.00 P.M. to 2.00 A.M.	June 22, . . . . .	.04	9.10 A.M. to 8.30 P.M.
Feb. 20, . . . . .	.16 ¹	11.00 A.M. to 7.30 A.M.	Total,	2.40	
Feb. 22, . . . . .	.16 ¹	3.00 P.M. to 2.00 A.M.			
Feb. 23,	1.09	12.15 A.M. to 9.45 A.M.	July 1, . . . . .	.25	6.50 P.M. to 4.00 A.M.
Feb. 26,	1.22	11.00 A.M. to 7.30 A.M.	July 2, . . . . .	.03	12.00 M. to 5.40 P.M.
Feb. 28,			July 4, . . . . .	.19	10.30 A.M. to 1.15 P.M.
Mar. 1,			July 5, . . . . .	.08	3.00 P.M. to 4.10 P.M.
Total,	4.04		July 6, . . . . .	.05	1.15 A.M. to 3.30 A.M.
Mar. 1, . . . . .	.10	7.30 A.M. to 3.30 P.M.	July 10, . . . . .	.10	4.15 P.M. to 5.30 P.M.
Mar. 4, . . . . .	.33 ¹	5.00 P.M. to 3.00 A.M.	July 11, . . . . .	.25	10.20 P.M. to 2.15 A.M.
Mar. 5, . . . . .	.10	6.00 A.M. to 9.00 A.M.	July 12, . . . . .	.63	4.15 P.M. to 5.30 P.M.
Mar. 6, . . . . .	.40 ¹	12.45 A.M. to 3.15 P.M.	July 14, . . . . .	.78	2.00 P.M. to 5.00 P.M.
Mar. 7, . . . . .	.64 ²	7.30 P.M. to 12.30 A.M.	July 15, . . . . .	.05	8.05 P.M. to 8.50 P.M.
Mar. 9, . . . . .	.11 ¹	5.30 A.M. to 8.00 P.M.	July 17, . . . . .	.24	4.30 P.M. to 8.30 P.M.
Mar. 10, . . . . .	.06 ¹	4.30 A.M. to 12.00 M.	July 18, . . . . .	.06	6.20 P.M. to 7.05 P.M.
Mar. 14, . . . . .	.24	12.00 M. to 9.00 P.M.	July 30,	1.22	1.20 P.M. to 11.15 A.M.
Mar. 14,			July 31,		
Total,	1.98		Total,	3.93	
Apr. 3, . . . . .	.23	1.00 P.M. to 1.30 A.M.	Aug. 5, . . . . .	.10	4.20 A.M. to 6.30 A.M.
Apr. 4, . . . . .	.83 ²	11.30 P.M. to 8.00 A.M.	Aug. 8, . . . . .	.86	4.15 P.M. to 8.00 A.M.
Apr. 11, . . . . .	.29	8.00 A.M. to 3.30 A.M.	Aug. 11, . . . . .	.14	6.30 P.M. to 9.15 P.M.
Apr. 13, . . . . .	.33	9.35 P.M. to 4.30 A.M.	Aug. 14, . . . . .	.08	7.30 A.M. to 10.40 P.M.
Apr. 14,	1.55	6.30 P.M. to 11.45 P.M.	Aug. 24, . . . . .	.20	11.30 A.M. to 6.30 P.M.
Apr. 17, . . . . .	.08	11.15 P.M. to 7.30 A.M.	Aug. 29, . . . . .	.30	3.20 A.M. to 5.30 A.M.
Apr. 18, . . . . .	.04	4.10 P.M. to 7.30 A.M.	Aug. 31,		
Apr. 20,	1.15	1.30 A.M. to 7.30 A.M.	Total,	1.68	
Apr. 21,					
Apr. 23,					
Apr. 24,					
Apr. 29,					
Apr. 30,					
May 1,					
Total,	4.50				

¹ Snow.² Rain and snow.

TABLE No. 5. — *Rainfall in Inches on the Wachusett Watershed, 1897 to 1918.*

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
1897.	5.11	8.65	3.47	1.93	0.94	7.62	6.11	51.81
1898.	3.11	3.01	10.61	3.15	7.21	6.81	3.99	57.92
1899.	5.51	3.82	3.20	4.11	2.72	1.94	2.03	41.40
1900.	3.59	3.20	3.18	3.46	2.90	6.44	3.15	52.46
1901.	1.51	5.66	4.58	3.10	3.70	2.43	9.36	55.70
1902.	2.51	3.87	3.95	4.26	6.36	0.93	7.20	48.58
1903.	10.37	3.43	3.88	2.93	4.43	2.36	3.99	49.58
1904.	3.44	3.84	3.68	5.30	1.78	1.62	2.88	43.06
1905.	4.88	5.39	3.09	6.90	1.81	2.52	3.79	43.58
1906.	5.95	5.52	4.34	2.61	3.95	2.25	4.26	49.08
1907.	3.54	3.03	1.26	9.50	5.68	5.71	4.40	45.74
1908.	1.29	3.85	6.49	1.04	2.13	1.05	3.03	37.83
1909.	3.03	4.25	3.59	3.90	1.70	1.68	3.99	44.50
1910.	4.36	1.52	3.87	2.86	1.40	4.17	2.34	37.85
1911.	2.37	2.53	5.46	3.04	5.24	4.11	3.01	38.73
1912.	0.48	2.65	2.89	2.17	2.53	4.02	4.95	40.19
1913.	0.90	2.37	3.05	4.14	6.02	2.59	2.73	41.22
1914.	2.00	3.92	4.50	0.15	1.88	2.97	3.89	38.54
1915.	3.18	8.60	6.90	1.53	3.05	3.12	5.11	41.65
1916.	6.57	5.66	1.72	4.21	1.42	3.15	2.81	43.43
1917.	3.89	4.47	1.22	1.20	6.03	1.25	2.31	37.26
1918.	4.57	2.80	2.82	7.18	1.58	3.08	3.74	39.77
Totals.	82.74	88.79	90.99	78.97	74.46	71.88	89.37	982.91
Average (22 years).	3.76	4.04	4.14	3.59	3.38	3.27	4.06	44.68

¹ Means of observations at four places, as follows: January, 1897, to December, 1900, Princeton, Jefferson, Sterling and South Clinton; January, 1901, to December, 1916, Princeton, Jefferson, Sterling and Boylston.

TABLE No. 6. — *Rainfall in Inches on the Sudbury Watershed,¹ 1875 to 1918.*

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
1875,													
1876,	2.42	3.15	3.74	3.23	3.56	6.21	3.57	5.53	3.43	4.85	4.83	0.91	45.49
1877,	1.83	4.21	7.43	2.76	2.76	2.01	9.13	1.72	4.02	2.24	5.76	3.62	49.56
1878,	3.22	0.74	8.36	3.43	3.70	2.43	2.95	3.68	0.32	8.52	5.80	0.87	44.02
1879,	5.63	5.97	4.69	5.79	0.96	3.88	2.97	6.91	1.29	6.42	7.02	6.37	57.93
1880,	2.48	3.56	5.14	4.72	1.58	3.79	3.93	6.51	1.88	0.81	2.68	4.34	41.42
1881,	3.57	3.98	3.31	3.11	1.84	2.14	6.27	4.01	1.60	3.74	1.78	2.83	38.18
1882,	5.56	4.65	5.73	2.00	3.51	5.39	2.35	1.36	2.62	2.95	4.09	3.96	44.17
1883,	5.95	4.55	2.65	1.82	5.07	1.66	1.77	1.67	8.74	2.07	1.15	2.30	39.40
1884,	2.81	3.87	1.78	1.81	4.19	2.40	2.68	0.73	1.52	5.60	1.81	3.55	32.78
1885,	5.09	6.54	4.72	4.41	3.47	3.44	3.67	4.65	0.85	2.48	2.65	5.17	47.14
1886,	4.71	3.87	1.07	3.60	3.48	2.87	1.43	7.18	1.43	5.09	6.09	2.72	43.51
1887,	6.36	6.28	3.61	2.22	3.00	1.47	3.27	4.10	2.90	3.24	4.64	4.97	46.06
1888,	5.20	4.78	4.90	4.27	1.16	2.65	3.76	5.28	1.32	2.83	2.67	3.88	42.70
1889,	4.15	3.68	6.02	2.43	4.82	2.54	1.41	6.22	8.59	4.99	7.22	5.40	57.47
1890,	5.37	1.65	2.37	3.41	2.95	2.80	8.94	4.18	4.60	4.25	6.29	3.14	49.95
1891,	2.53	3.51	7.73	2.64	5.21	2.03	2.46	3.87	6.00	10.51	1.20	5.31	53.90
1892,	7.02	5.23	6.48	3.91	2.01	3.77	3.39	4.73	2.38	3.83	3.09	3.68	49.52
1893,	5.85	3.14	4.06	0.83	5.58	2.76	4.23	4.44	2.84	1.17	5.80	1.13	41.83
1894,	2.92	8.20	3.67	3.60	6.01	2.38	2.57	5.41	1.74	4.07	2.20	4.86	48.23
1895,	4.09	3.91	1.43	3.42	4.24	1.15	3.26	2.03	2.63	5.34	3.43	4.81	39.74
1896,	4.06	1.39	2.98	5.25	2.02	2.77	5.04	4.15	2.30	10.68	6.63	3.35	50.62
1897,	2.39	7.18	5.24	1.57	2.57	3.22	2.51	2.40	7.72	3.76	3.02	2.12	43.70
1898,	4.00	2.91	3.66	2.82	4.37	4.46	5.44	3.51	2.94	0.47	6.40	5.21	46.19
1899,	6.83	4.49	2.40	4.66	3.22	2.48	4.09	8.17	2.02	6.71	6.93	3.28	55.88
1900,	4.18	4.91	7.01	1.90	1.45	2.51	3.22	1.43	3.95	2.69	2.18	1.78	37.21
	4.96	9.14	6.35	2.58	4.32	2.99	2.42	2.26	3.36	3.83	5.70	2.74	50.65

¹ See note at end of this table.

TABLE No. 6. — *Rainfall in Inches on the Sudbury Watershed, 1875 to 1918 — Concluded.*

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
1901,	1.82	1.52	6.57	8.60	7.23	1.38	5.71	4.57	3.30	2.82	2.90	9.69	56.11
1902,	2.52	6.18	5.34	4.13	1.86	2.89	2.94	3.40	4.54	4.44	1.45	6.38	46.07
1903,	3.80	3.95	6.63	2.99	0.93	9.25	2.77	3.67	1.75	4.72	1.56	3.14	45.16
1904,	4.87	3.00	2.72	8.87	2.65	2.80	1.96	3.86	5.80	1.64	1.73	2.92	42.82
1905,	5.26	2.20	3.15	2.72	1.31	5.00	5.47	2.70	6.88	1.54	2.07	4.01	42.31
1906,	2.47	2.92	6.32	2.88	5.66	3.91	3.42	3.02	3.30	3.40	2.69	4.49	44.48
1907,	3.28	2.17	1.91	3.41	3.63	3.53	1.86	1.07	8.76	4.17	6.12	4.47	44.38
1908,	3.60	4.56	3.82	1.88	5.51	0.86	3.71	4.57	0.97	2.55	0.98	3.14	36.15
1909,	3.98	5.79	4.26	4.67	2.43	2.81	1.59	2.93	4.74	1.12	3.38	4.05	41.75
1910,	5.39	5.06	0.85	2.75	1.29	4.68	2.03	2.62	2.49	1.86	4.13	2.49	35.64
1911,	2.88	2.77	3.59	2.81	1.01	2.53	3.19	4.94	2.75	3.69	4.62	3.60	38.38
1912,	2.94	2.77	6.46	4.37	4.55	0.46	3.24	3.05	1.76	2.35	3.64	5.13	40.72
1913,	3.17	2.82	5.75	4.25	3.97	1.98	3.60	3.64	3.77	5.53	2.65	3.18	44.31
1914,	3.85	4.07	4.57	5.10	3.08	1.90	3.44	3.82	0.29	1.60	2.53	3.46	37.71
1915,	6.51	3.58	0.05	2.48	1.74	3.65	8.12	5.87	1.10	2.95	2.79	5.09	43.93
1916,	1.53	5.91	4.16	4.19	3.43	4.77	5.17	2.01	1.80	1.49	2.28	3.22	39.96
1917,	3.50	2.68	4.96	2.41	4.93	4.23	1.11	6.40	1.52	5.65	1.31	2.81	41.51
1918,	3.47	3.58	2.50	4.43	1.16	3.65	4.07	1.61	8.60	1.04	2.75	3.68	40.54
Totals,	178.02	181.02	190.14	156.60	144.02	130.54	160.13	169.91	148.31	165.70	160.04	167.28	1,958.31
Average (44 years),	4.05	4.12	4.32	3.56	3.27	3.10	3.64	3.86	3.37	3.77	3.65	3.80	44.51

¹ Means of observations at several places, as follows: January, 1875, to March, 1876, inclusive, Lake Cochituate; April and May, 1876, Lake Cochituate, Westborough and Hopkinton; June to November, 1876, inclusive, Lake Cochituate, Southborough, Marlborough, Westborough and Hopkinton; December, 1876, to December, 1882, inclusive, Framingham, Southborough, Marlborough and Hopkinton; January, 1883, to December, 1889, inclusive, Framingham and Westborough; January, 1890, to May, 1898, inclusive, Framingham and Ashland Dam; June, 1898, to December, 1916, inclusive, Framingham, Ashland Dam, Cordaville and Sudbury Dam.

TABLE NO. 7. — *Yield of the Wachusett Watershed in Gallons per Day per Square Mile¹ from 1897 to 1918.*

MONTH.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.
January,	796,000	1,563,000	2,092,000	796,000	519,000	1,076,000	1,265,000	659,000	1,266,000	1,132,000	1,458,000
February,	931,000	1,655,000	1,090,000	4,054,000	356,000	1,401,000	2,133,000	927,000	452,000	1,027,000	692,000
March,	2,760,000	3,088,000	2,776,000	3,722,000	2,718,000	3,992,000	3,423,000	3,008,000	3,004,000	1,860,000	1,697,000
April,	1,632,000	2,027,000	3,376,000	1,580,000	4,986,000	2,159,000	2,238,000	2,984,000	1,617,000	2,109,000	1,436,000
May,	1,103,000	1,390,000	802,000	1,382,000	2,729,000	1,031,000	569,000	1,498,000	445,000	1,533,000	965,000
June,	1,181,000	828,000	561,000	578,000	985,000	410,000	2,131,000	762,000	542,000	1,184,000	773,000
July,	1,442,000	333,000	354,000	217,000	477,000	292,000	624,000	497,000	365,000	728,000	335,000
August,	896,000	1,325,000	236,000	197,000	512,000	297,000	474,000	355,000	321,000	591,000	87,000
September,	380,000	676,000	250,000	127,000	320,000	241,000	375,000	494,000	1,228,000	277,000	810,000
October,	243,000	1,509,000	215,000	282,000	647,000	950,000	689,000	347,000	367,000	530,000	1,382,000
November,	1,283,000	2,170,000	430,000	875,000	517,000	635,000	634,000	343,000	442,000	749,000	2,540,000
December,	2,275,000	2,061,000	359,000	1,570,000	3,234,000	1,818,000	954,000	440,000	1,018,000	794,000	1,961,000
Average,	1,253,000	1,551,000	1,051,000	1,264,000	1,507,000	1,248,000	1,285,000	1,023,000	926,000	1,043,000	1,180,000
Average, driest six months,	886,000	1,013,000	312,000	377,000	576,000	471,000	626,000	413,000	541,000	613,000	725,000

¹ See note at end of this table.

TABLE No. 7. — *Yield of the Wachusett Watershed in Gallons per Day per Square Mile¹ from 1897 to 1918* — Concluded.

MONTH.	1908.	1909.	1910.	1911.	1912.	1913.	1914.	1915.	1916.	1917.	1918.	Mean for 22 Years, 1897-1918.
January,	1,738,000	592,000	1,846,000	773,000	780,000	1,414,000	990,000	2,063,000	1,315,000	686,000	481,000	1,177,000
February,	1,736,000	2,556,000	1,845,000	625,000	927,000	867,000	1,181,000	1,961,000	1,816,000	916,000	2,021,000	1,416,000
March,	2,192,000	2,129,000	2,040,000	1,339,000	2,831,000	2,263,000	3,137,000	572,000	1,891,000	2,472,000	2,590,000	2,550,000
April,	1,269,000	2,422,000	1,034,000	1,393,000	2,281,000	2,083,000	2,593,000	926,000	3,300,000	1,468,000	1,608,000	2,415,000
May,	1,415,000	1,212,000	608,000	461,000	1,797,000	1,038,000	1,699,000	455,000	1,697,000	1,317,000	673,000	1,179,000
June,	403,000	632,000	821,000	351,000	331,000	280,000	317,000	228,000	2,054,000	1,229,000	523,000	778,000
July,	220,000	233,000	62,000	57,000	135,000	19,000	329,000	1,083,000	1,086,000	294,000	280,000	429,000
August,	443,000	193,000	186,000	188,000	125,000	60,000	261,000	1,657,000	284,000	309,000	159,000	416,000
September,	88,000	208,000	145,000	181,000	89,000	219,000	—12,000	158,000	294,000	84,000	603,000	329,000
October,	158,000	90,000	68,000	718,000	145,000	678,000	136,000	387,000	140,000	555,000	341,000	482,000
November,	125,000	363,000	354,000	1,035,000	442,000	660,000	211,000	498,000	321,000	313,000	582,000	706,000
December,	387,000	537,000	391,000	1,067,000	793,000	955,000	372,000	1,359,000	460,000	389,000	1,056,000	1,101,000
Average,	847,000	918,000	828,000	682,000	891,000	879,000	934,000	942,000	1,215,000	834,000	902,000	1,055,000
Average, driest six months,	238,000	270,000	201,000	327,000	210,000	318,000	208,000	666,000	432,000	330,000	412,000	522,000

¹ The area of the watershed used in making up these records included water surfaces amounting to 2.2 per cent. of the whole area from 1897 to 1902 inclusive, 2.4 per cent. in 1903, 3.6 per cent. in 1904, 4.1 per cent. in 1905, 5.1 per cent. in 1906, 6.0 per cent. in 1907, 7.0 per cent. in 1908, 1909 and 1910, 6.5 per cent. in 1911, 6.8 per cent. in 1912, 6.9 per cent. in 1913, 7.4 per cent. in 1914 and 1915, 7.6 per cent. in 1916, 7.4 per cent. in 1917, 7.2 per cent. in 1918.

TABLE No. 8. — Yield of the Sudbury Watershed in Gallons per Day per Square Mile¹ from 1875 to 1918.

Month.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.
January,	103,000	643,000	658,000	1,810,000	700,000	1,120,000	415,000	1,241,000	335,000	995,000	1,235,000
February,	1,496,000	1,368,000	949,000	2,465,000	1,711,000	1,787,000	1,546,000	2,403,000	1,033,000	2,842,000	1,354,000
March,	1,604,000	4,435,000	4,814,000	3,507,000	2,330,000	1,374,000	4,004,000	2,839,000	1,611,000	3,785,000	1,572,000
April,	3,049,000	3,292,000	2,394,000	1,628,000	3,116,000	1,169,000	1,546,000	867,000	1,350,000	2,853,000	1,815,000
May,	1,188,000	1,138,000	1,391,000	1,394,000	1,114,000	514,000	965,000	1,292,000	937,000	1,030,000	1,336,000
June,	870,000	222,000	597,000	506,000	413,000	175,000	1,338,000	529,000	300,000	416,000	426,000
July,	321,000	183,000	202,000	128,000	157,000	176,000	276,000	86,000	115,000	224,000	62,000
August,	396,000	405,000	121,000	476,000	395,000	119,000	148,000	55,000	79,000	257,000	240,000
September,	207,000	184,000	60,000	161,000	141,000	80,000	197,000	307,000	91,000	44,000	121,000
October,	646,000	234,000	631,000	516,000	71,000	102,000	186,000	299,000	186,000	83,000	336,000
November,	1,392,000	1,088,000	1,418,000	1,693,000	206,000	205,000	395,000	209,000	205,000	175,000	1,177,000
December,	584,000	453,000	1,290,000	3,177,000	463,000	175,000	775,000	315,000	194,000	925,000	1,174,000
Average,	972,000	1,135,000	1,214,000	1,452,000	894,000	578,000	979,000	862,000	533,000	1,129,000	901,000
Average, driest six months, . .	574,000	384,000	502,000	532,000	230,000	143,000	330,000	211,000	145,000	200,000	391,000

¹ See note at end of this table.

TABLE No. 8. — *Yield of the Sudbury Watershed in Gallons per Day per Square Mile¹ from 1875 to 1918* — Continued.

MONTH.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.
January,	1,461,000	2,589,000	1,053,000	2,782,000	1,254,000	3,018,000	1,870,000	434,000	693,000	1,031,000	1,084,000
February,	4,801,000	2,829,000	1,950,000	1,196,000	1,529,000	3,486,000	913,000	1,542,000	991,000	541,000	2,676,000
March,	2,059,000	2,808,000	3,238,000	1,338,000	3,643,000	4,453,000	1,955,000	3,245,000	2,238,000	2,410,000	3,835,000
April,	1,947,000	2,620,000	2,645,000	1,410,000	1,875,000	2,397,000	871,000	2,125,000	1,640,000	2,515,000	1,491,000
May,	720,000	1,009,000	1,632,000	880,000	1,366,000	583,000	1,259,000	2,883,000	840,000	636,000	390,000
June,	203,000	413,000	421,000	653,000	558,000	413,000	428,000	440,000	419,000	174,000	399,000
July,	116,000	115,000	117,000	634,000	107,000	149,000	214,000	158,000	161,000	231,000	95,000
August,	94,000	214,000	379,000	1,432,000	132,000	163,000	280,000	181,000	209,000	229,000	57,000
September,	117,000	111,000	1,155,000	823,000	457,000	203,000	229,000	108,000	150,000	89,000	388,000
October,	146,000	190,000	1,999,000	1,230,000	2,272,000	210,000	126,000	222,000	374,000	1,379,000	592,000
November,	673,000	369,000	2,758,000	1,941,000	1,215,000	305,000	697,000	319,000	836,000	2,777,000	639,000
December,	1,020,000	643,000	3,043,000	2,241,000	996,000	544,000	485,000	790,000	716,000	1,782,000	637,000
Average,	1,087,000	1,154,000	1,697,000	1,383,000	1,285,000	1,315,000	781,000	1,037,000	770,000	1,152,000	1,019,000
Average, driest six months,	223,000	234,000	953,000	944,000	747,000	239,000	327,000	237,000	356,000	460,000	314,000

¹ See note at end of this table.

TABLE No. 8. — *Yield of the Sudbury Watershed in Gallons per Day per Square Mile¹ from 1875 to 1918* — Continued.

MONTH.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.
January,	845,000	1,638,000	2,288,000	794,000	437,000	1,763,000	1,736,000	477,000	1,410,000	1,128,000	1,351,000
February,	1,067,000	3,022,000	1,381,000	3,800,000	300,000	1,674,000	2,279,000	882,000	330,000	1,041,000	624,000
March,	2,565,000	2,604,000	4,205,000	3,654,000	2,755,000	4,199,000	3,454,000	2,999,000	2,497,000	2,409,000	1,658,000
April,	1,515,000	1,829,000	2,521,000	1,350,000	4,204,000	1,885,000	2,261,000	3,294,000	1,643,000	1,949,000	1,607,000
May,	915,000	1,246,000	511,000	1,312,000	2,854,000	743,000	351,000	1,745,000	297,000	1,039,000	888,000
June,	962,000	530,000	66,000	316,000	753,000	303,000	1,987,000	419,000	467,000	707,000	761,000
July,	658,000	231,000	19,000	—18,000	306,000	66,000	445,000	62,000	177,000	398,000	9,000
August,	591,000	1,107,000	—35,000	—34,000	424,000	135,000	307,000	170,000	114,000	180,000	—104,000
September,	182,000	369,000	94,000	65,000	365,000	178,000	136,000	397,000	1,240,000	19,000	541,000
October,	94,000	1,160,000	115,000	186,000	412,000	506,000	492,000	191,000	158,000	301,000	741,000
November,	909,000	1,986,000	304,000	663,000	474,000	444,000	363,000	289,000	279,000	483,000	1,998,000
December,	1,584,000	1,799,000	230,000	1,096,000	2,695,000	1,779,000	582,000	269,000	887,000	659,000	2,032,000
Average,	991,000	1,450,000	973,000	1,082,000	1,342,000	1,140,000	1,190,000	931,000	795,000	800,000	1,010,000
Average, driest six months, .	564,000	777,000	93,000	194,000	445,000	271,000	388,000	228,000	403,000	341,000	471,000

¹ See note at end of this table.

TABLE No. 8. — *Yield of the Sudbury Watershed in Gallons per Day per Square Mile from 1875 to 1918* — Concluded.

MONTH.	1908.	1909.	1910.	1911.	1912.	1913.	1914.	1915.	1916.	1917.	1918.	Mean for 44 Years, 1875-1918.
January,	1,925,000	392,000	1,490,000	519,000	728,000	1,041,000	908,000	1,629,000	942,000	510,000	273,000	1,153,000
February,	1,536,000	2,286,000	1,849,000	700,000	1,197,000	754,000	1,009,000	1,870,000	1,356,000	755,000	1,809,000	1,658,000
March,	2,257,000	1,734,000	1,554,000	1,144,000	3,092,000	2,090,000	3,029,000	593,000	1,820,000	2,209,000	2,187,000	2,688,000
April,	1,117,000	1,721,000	667,000	1,426,000	2,235,000	2,232,000	2,353,000	590,000	3,037,000	1,405,000	1,466,000	1,976,000
May,	1,046,000	1,004,000	277,000	318,000	1,447,000	867,000	1,550,000	255,000	1,439,000	1,476,000	639,000	1,064,000
June,	194,000	239,000	516,000	213,000	148,000	149,000	5,000	101,000	1,198,000	1,044,000	185,000	491,000
July,	—44,000	—121,000	—102,000	—14,000	—77,000	—62,000	107,000	1,045,000	585,000	43,000	96,000	179,000
August,	102,000	—45,000	—73,000	20,000	—29,000	—54,000	156,000	1,168,000	78,000	202,000	—54,000	236,000
September,	—82,000	149,000	5,000	76,000	—28,000	88,000	—135,000	38,000	26,000	58,000	637,000	222,000
October,	47,000	—51,000	—51,000	296,000	—14,000	484,000	—59,000	231,000	—5,000	482,000	274,000	410,000
November,	71,000	82,000	176,000	593,000	165,000	480,000	97,000	261,000	110,000	438,000	489,000	722,000
December,	136,000	263,000	221,000	908,000	494,000	732,000	250,000	898,000	315,000	380,000	938,000	945,000
Average,	694,000	625,000	570,000	514,000	779,000	733,000	772,000	719,000	904,000	750,000	736,000	975,000
Average, driest six months, .	44,000	40,000	29,000	151,000	26,000	180,000	29,000	480,000	186,000	267,000	269,000	375,000

¹ The area of the Sudbury watershed used in these records included water surfaces amounting to 1.9 per cent. of the whole area from 1875 to 1878, inclusive, and was subsequently increased by the construction of storage reservoirs, to 3.0 per cent. in 1879, 3.4 per cent. in 1885, 3.9 per cent. in 1894, and 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

NOTE. — The recorded yields, subsequent to the year 1897, are less accurate than those for previous years, particularly during months of small yield, due to unavoidable inaccuracies in the measurement of large quantities of water received from the Wachusett Reservoir.

TABLE NO. 9. — *Wachusett System. — Statistics of Flow of Water, Storage and Rainfall in 1918.*
[Watershed above dam = 108.84 square miles.]

MONTH.	GALLONS PER DAY.						Rainfall collected (Inches).	Percent- age of Rainfall collected.	
	Received from City of Worcester Watershed.	Discharged into Wachusett Aqueduct. ¹	Wasted into River below Dam.	Seepage through the North Dike. ²	STORAGE. ³				Total Yield of Watershed.
					Gain.	Loss.			
January,	-	134,848,000	4,452,000	835,000	-	87,416,000	2.97	0.864	29.1
February,	-	105,329,000	3,979,000	807,000	110,121,000	-	4.25	3.200	76.6
March,	11,021,000	60,485,000	3,395,000	891,000	228,158,000	-	2.24	4.614	206.0
April,	8,073,000	103,930,000	2,523,000	957,000	75,630,000	-	3.47	2.775	80.0
May,	-	105,168,000	2,942,000	974,000	-	35,807,000	1.07	1.201	112.8
June,	-	139,197,000	2,663,000	947,000	-	85,900,000	4.57	0.902	19.8
July,	-	132,174,000	2,861,000	913,000	-	105,509,000	2.80	0.499	17.8
August,	-	134,622,000	3,245,000	881,000	-	121,445,000	2.82	0.284	10.1
September,	-	96,867,000	3,403,000	830,000	-	35,480,000	7.18	1.041	14.5
October,	-	92,919,000	2,745,000	809,000	-	59,352,000	1.58	0.609	38.6
November,	-	101,863,000	1,827,000	800,000	-	41,170,000	3.08	1.004	32.6
December,	-	96,437,000	1,758,000	787,000	15,983,000	-	3.74	1.884	50.4
Total,	-	-	-	-	-	-	39.77	18.937	-
Average for year,	1,598,000	108,667,000	2,978,000	870,000	-	12,779,000	-	-	47.6

¹ Including 164,000 gallons per day drawn from aqueduct for the supply of the Westborough State Hospital.
² Estimated.
³ Aggregate storage in Wachusett Reservoir and in ponds and mill reservoirs.

TABLE No. 10. — *Sudbury System. — Statistics of Flow of Water, Storage and Rainfall in 1918.*

[Watershed = 75.2 square miles.]

MONTH.	GALLONS PER DAY.										Rain-fall col- lected (In- ches).	Rain- fall (In- ches).	Percent- age of Rain- fall col- lected.
	Water received from Wachusett Reservoir. ¹	Water discharged through Sudbury Aqueduct.	Water discharged through Weston Aqueduct.	Water used by Framing- ham Water Works.	Water di- verted from Watershed by Sewers, etc.	Water wasted into River below Lowest Dam.	STORAGE.		Total Yield of River Watershed.				
							Gain.	Loss.					
January, . .	134,684,000	92,297,000	48,471,000	1,452,000	906,000	14,223,000	—	2,165,000	20,500,000	3.47	0.486	14.0	
February, . .	105,154,000	85,218,000	63,754,000	1,682,000	1,747,000	68,032,000	20,732,000	—	136,011,000	3.58	2.914	81.3	
March, . .	60,317,000	68,360,000	67,804,000	1,357,000	1,887,000	104,482,000	—	19,116,000	164,457,000	2.50	3.896	156.2	
April, . .	103,757,000	67,850,000	49,070,000	993,000	1,687,000	66,017,000	28,347,000	—	110,207,000	4.43	2.530	57.1	
May, . .	105,026,000	75,274,000	45,055,000	1,171,000	1,097,000	31,023,000	—	507,000	48,087,000	1.16	1.141	98.8	
June, . .	139,023,000	82,060,000	42,160,000	1,117,000	766,000	10,654,000	16,170,000	—	13,903,000	3.65	0.319	8.7	
July, . .	131,997,000	79,622,000	45,865,000	1,126,000	642,000	6,655,000	5,322,000	—	7,235,000	4.07	0.171	4.2	
August, . .	134,465,000	84,255,000	43,777,000	1,110,000	600,000	2,932,000	—	2,267,000	—4,058,000	1.61	—0.096	—6.0	
September, . .	96,707,000	68,750,000	47,333,000	1,057,000	1,134,000	22,123,000	4,240,000	—	47,930,000	8.60	1.100	12.8	
October, . .	92,778,000	62,586,000	52,548,000	1,169,000	1,462,000	14,592,000	—	18,955,000	20,624,000	1.04	0.490	47.0	
November, . .	101,713,000	65,570,000	50,113,000	1,013,000	1,080,000	32,500,000	—	11,823,000	36,740,000	2.75	0.843	30.7	
December, . .	96,284,000	64,329,000	51,058,000	877,000	1,110,000	47,132,000	2,307,000	—	70,529,000	3.68	1.673	45.5	
Total, . .	—	—	—	—	—	—	—	—	—	40.54	15.467	—	
Av. for year, . .	108,503,000	74,633,000	50,512,000	1,174,000	1,172,000	34,773,000	1,621,000	—	55,382,000	—	—	38.2	

¹ Not including 164,000 gallons per day drawn from the Wachusett Aqueduct for the supply of the Westborough State Hospital, which were not discharged into Sudbury Reservoir.

TABLE NO. 11. — *Cochituate System.* — *Statistics of Flow of Water, Storage and Rainfall in 1918.*
 [Watershed of lake=17.58 square miles.¹]

MONTH.	GALLONS PER DAY.						Rainfall (Inches).	Rainfall collected (Inches).	Percent- age of Rainfall collected.
	Water discharged through Cochituate Aqueduct.	Water di- verted from Watershed by Sewers, etc.	Water wasted at Outlet of Lake.	STORAGE.		Total Yield of Watershed.			
				Gain.	Loss.				
January,	1,200,000	416,000	5,668,000	1,619,000	—	8,903,000	3.26	0.91	27.7
February,	4,189,000	511,000	20,364,000	6,154,000	—	31,218,000	3.80	2.86	75.3
March,	—	885,000	34,786,000	—	2,607,000	33,064,000	2.26	3.35	143.3
April,	—	1,440,000	6,987,000	14,923,000	—	23,350,000	4.61	2.29	49.7
May,	—	1,081,000	9,484,000	190,000	—	10,755,000	1.10	1.09	99.2
June,	—	627,000	1,213,000	1,823,000	—	3,663,000	3.34	0.36	10.8
July,	—	516,000	2,410,000	—	78,000	2,818,000	3.64	0.29	7.9
August,	—	426,000	161,000	—	1,152,000	—565,000	1.41	—0.06	—4.1
September,	—	727,000	12,440,000	1,030,000	—	14,197,000	8.58	1.40	16.2
October,	—	937,000	5,344,000	—	457,000	5,824,000	0.92	0.59	64.3
November,	—	893,000	13,430,000	—	4,423,000	9,900,000	2.57	0.97	37.8
December,	—	1,313,000	22,532,000	—	5,397,000	18,448,000	3.55	1.87	52.7
Total,	—	—	—	—	—	—	39.04	15.92	—
Average for year,	423,000	816,000	11,186,000	901,000	—	13,326,000	—	—	40.8

¹ Not including the watersheds of Dudley and Dug ponds.

TABLE NO. 12. — *Elevations of Water Surfaces of Reservoirs above Boston City Base at the Beginning of Each Month.*

DATE.	Chestnut Hill Reservoir.	Lake Cochituate.	Farm Pond.	Spot Pond.	Weston Reservoir.	FRAMINGHAM RESERVOIR.			Ashland Reservoir.	Sudbury Reservoir.	Hopkinton Reservoir.	Whitchell Reservoir.	Wachusett Reservoir.
						No. 1.	No. 2.	No. 3.					
	Ordinary High Water = 134.00.	High Water = 144.36.	High Water = 159.25.	High Water = 163.00.	High Water = 200.00.	Flash Boards 169.32.	Flash Boards 177.12.	Flash Boards 186.50.	Flash Boards 225.23.	Flash Boards 259.97.	Flash Boards 305.00.	Ordinary High Water = 337.91.	Ordinary High Water = 395.00.
Jan. 1, 1918,	132.52	141.91	157.75	162.05	198.41	167.71	176.02	183.25	223.59	257.52	303.30	336.79	385.94
Feb. 1, 1918,	132.46	141.79	158.20	160.88	199.74	167.66	176.02	183.73	223.28	257.61	302.49	336.23	383.63
Mar. 1, 1918,	133.74	142.54	158.67	160.64	199.82	168.31	176.06	185.25	224.44	258.17	303.27	336.50	385.91
Apr. 1, 1918,	133.81	142.19	158.70	162.56	199.66	167.94	176.34	184.19	224.49	256.62	304.19	336.92	391.53
May 1, 1918,	133.56	141.09	158.75	163.17	199.11	167.97	176.40	183.93	225.40	258.31	305.13	337.36	393.29
June 1, 1918,	133.66	141.13	158.28	163.15	199.09	169.40	177.33	184.16	225.27	257.91	305.04	337.61	392.53
July 1, 1918,	133.81	141.36	158.79	163.25	198.29	169.43	177.26	184.50	225.22	258.93	305.02	337.76	390.60
Aug. 1, 1918,	133.98	141.35	158.41	163.12	199.77	169.39	177.21	185.45	225.25	259.19	304.95	337.80	388.16
Sept. 1, 1918,	133.92	141.20	158.11	163.48	200.42	169.37	177.16	186.08	225.08	259.10	304.75	337.58	385.21
Oct. 1, 1918,	134.40	141.33	158.49	163.44	197.98	169.60	177.44	185.52	225.31	259.20	305.04	337.87	384.23
Nov. 1, 1918,	133.81	141.27	158.20	163.04	199.61	169.44	177.27	185.34	225.30	257.87	305.02	337.85	382.68
Dec. 1, 1918,	134.03	143.71	158.05	163.15	200.02	167.76	176.08	184.80	224.33	257.81	304.11	337.69	381.52
Jan. 1, 1919,	133.85	142.91	158.12	163.07	199.92	167.87	176.20	185.09	224.50	258.24	304.18	336.90	381.88

TABLE NO. 13. — *Sources from which and Periods during which Water has been drawn for the Supply of the Metropolitan Water District.**From Wachusett Reservoir into the Wachusett Aqueduct.*

MONTH.	Number of Days during which Water was flowing.	ACTUAL TIME.		Million Gallons drawn.
		Hours.	Minutes.	
January,	26	292	4	4,180.3
February,	22	241	50	2,949.2
March,	26	231	40	1,872.5
April,	26	236	5	3,117.9
May,	26	251	25	3,261.2
June,	25	288	45	4,175.9
July,	26	301	49	4,097.4
August,	27	293	50	4,173.3
September,	22	226	6	2,906.0
October,	24	219	—	2,884.4
November,	23	208	35	3,055.9
December,	25	234	55	2,989.5
Totals,	298	3,020	364	39,663.5

Total actual time, 126.09 days.

Total quantity drawn, 39,663,500,000 gallons.

From Sudbury Reservoir through the Weston Aqueduct to Weston Reservoir.

MONTH.	Number of Days during which Water was flowing.	ACTUAL TIME.		Million Gallons drawn.
		Hours.	Minutes.	
January,	26	353	49	1,502.6
February,	28	406	5	1,785.1
March,	31	471	46	2,099.1
April,	26	372	50	1,472.1
May,	26	361	1	1,396.7
June,	25	325	00	1,264.8
July,	26	355	44	1,421.8
August,	26	354	58	1,357.1
September,	24	364	10	1,420.0
October,	26	386	28	1,631.2
November,	25	377	00	1,503.4
December,	25	376	20	1,582.8
Totals,	314	4,505	11	18,436.7

Total actual time, 187.72 days.

Total quantity drawn, 18,436,700,000 gallons.

TABLE NO. 13 — *Concluded.**From Framingham Reservoir No. 3 through the Sudbury Aqueduct to Chestnut Hill Reservoir.*

MONTH.	Number of Days during which Water was flowing.	Actual Time (Hours).	Million Gallons drawn.
January,	31	744	2,861.2
February,	28	672	2,386.1
March,	31	743	2,116.3
April,	30	720	2,035.5
May,	31	744	2,333.5
June,	30	711	2,461.8
July,	31	744	2,468.3
August,	31	744	2,611.9
September,	30	720	2,062.5
October,	31	745	1,942.8
November,	30	720	1,967.1
December,	31	744	1,994.2
Totals,	365	8,751	27,241.2

Total actual time, 364.63 days.

Total quantity drawn, 27,241,200,000 gallons.

TABLE NO. 14. — *Average Daily Quantity of Water flowing through Aqueduct in 1918 by Months.*¹

MONTH.	Wachusett Aqueduct into Sudbury Reservoir (Gallons).	Weston Aqueduct into Metropolitan District (Gallons).	Sudbury Aqueduct into Chestnut Hill Reservoir (Gallons).	Cochituate Aqueduct into Chestnut Hill Reservoir (Gallons).
January,	134,684,000	48,471,000	92,297,000	1,200,000
February,	105,154,000	63,754,000	85,218,000	4,189,000
March,	60,317,000	67,804,000	68,360,000	—
April,	103,757,000	49,070,000	67,850,000	—
May,	105,026,000	45,055,000	75,274,000	—
June,	139,023,000	42,160,000	82,060,000	—
July,	131,997,000	45,865,000	79,622,000	—
August,	134,465,000	43,777,000	84,255,000	—
September,	96,707,000	47,333,000	68,750,000	—
October,	92,778,000	52,548,000	62,586,000	—
November,	101,713,000	50,113,000	65,570,000	—
December,	96,284,000	51,058,000	64,329,000	—
Average,	108,503,000	50,512,000	74,633,000	423,000

¹ Not including quantities wasted while cleaning and repairing aqueducts.

TABLE No. 15. — Statement of Operations of Engines Nos. 1, 2, 3 and 4 at Chestnut Hill Pumping Station No. 1 for the Year 1918.

MONTH.	ENGINE NO. 1.			ENGINE NO. 2.			ENGINE NO. 3.			ENGINE NO. 4.			Total Quantity pumped, Corrected for Ship (Million Gallons).	Daily Average Quantity pumped, Corrected for Ship (Million Gallons).	Coal consumed in pumping (Pounds).	Coal used in banking (Pounds).	Per Cent. of Ashes and Clinkers.	
	Total Pumping Time.	Quantity pumped, 3 Per Cent. allowed for Ship (Million Gallons).	Average Lift (Feet).	Total Pumping Time.	Quantity pumped, 3 Per Cent. allowed for Ship (Million Gallons).	Average Lift (Feet).	Total Pumping Time.	Quantity pumped, 4 Per Cent. allowed for Ship (Million Gallons).	Average Lift (Feet).	Total Pumping Time.	Quantity pumped, 2 Per Cent. allowed for Ship (Million Gallons).	Average Lift (Feet).						
January, . . .	Hrs. Min. 482 30	168.82	132.12	Hrs. Min. 101 45	35.86	132.95	Hrs. Min. 1 1	-	-	-	Hrs. Min. 64 30	80.06	122.59	284.74	9.185	545,378	62,400	22.0
February, . . .	287 00	101.23	131.48	288 35	101.24	130.94	-	-	-	-	74 20	93.46	125.10	295.93	10.569	575,227	23,095	21.1
March, . . .	359 25	129.38	131.85	48 00	17.48	131.74	-	-	-	-	4 45	6.41	136.29	153.27	4.944	296,490	58,645	20.2
April, . . .	260 15	90.32	133.16	67 05	24.17	133.82	-	-	-	-	23 00	28.82	125.08	143.31	4.777	275,260	55,785	15.5
May, . . .	263 00	93.30	134.24	36 25	13.03	134.23	-	-	-	-	-	-	-	106.33	3.430	226,291	35,405	18.0
June, . . .	243 20	87.57	134.36	64 40	22.99	134.35	-	-	-	-	-	-	-	110.56	3.685	242,155	43,875	19.8
July, . . .	-	-	-	320 00	114.32	133.71	-	-	-	-	12 40	16.05	124.47	130.37	4.205	209,845	53,180	19.7
August, . . .	179 20	64.46	133.06	146 00	52.52	133.24	-	-	-	-	19 30	21.77	122.92	138.75	4.476	239,450	48,905	20.9
September, . . .	88 50	31.67	133.47	209 25	74.02	133.64	-	-	-	-	-	-	-	105.69	3.523	236,394	37,310	20.0
October, . . .	-	-	-	241 50	85.77	133.74	-	-	-	-	34 55	38.23	123.83	124.00	4.000	265,942	28,711	16.1
November, . . .	-	-	-	355 45	119.86	133.12	-	-	-	-	-	-	-	119.86	3.995	307,084	59,575	16.3
December, . . .	-	-	-	331 55	110.28	133.32	-	-	-	-	-	-	-	110.28	3.557	250,455	57,900	13.9
Total, . . .	2,163 40	766.75	-	2,211 25	771.54	-	-	-	-	-	233 40	284.80	-	1,823.09	-	3,729,971	564,786	-
Average, . . .	-	-	132.76	-	-	133.12	-	-	-	-	-	-	124.05	-	4.995	-	-	19.0

TABLE No. 16. — *Statement of Operations of Engines Nos. 5, 6, 7 and 12 at Chestnut Hill Pumping Station No. 2 for the Year 1918.*

Month.	ENGINE No. 5.			ENGINE No. 6.			ENGINE No. 7.			ENGINE No. 12.			Total Quantity pumped, 2 Per Cent. allowed for Ship (Million Gallons).	Daily Average Quantity pumped, 2 Per Cent. allowed for Ship (Million Gallons).	Total Coal consumed in pumping and banking in (Pounds).	Per Cent. of Ashes and Clinkers.
	Hrs. Min.	Total Pumping Time.	Quantity pumped, 2 Per Cent. allowed for Ship (Million Gal- lons).	Average Lift (Feet).	Hrs. Min.	Total Pumping Time.	Quantity pumped, 2 Per Cent. allowed for Ship (Million Gal- lons).	Average Lift (Feet).	Hrs. Min.	Total Pumping Time.	Quantity pumped, 2 Per Cent. allowed for Ship (Million Gal- lons).	Average Lift (Feet).				
January, . . .	603 25	610.04	31.14	29.07	744 00	756.60	756.60	29.07	5 05	35.64	718 15	124 72	2,539.46	81.918	1,697,880	24.5
February, . . .	609 05	723.32	53 05	52.29	618 25	671.15	671.15	48.02	86 25	82.62	670 35	124.39	2,562.32	91.511	1,700,280	20.5
March, . . .	741 30	758.04	61 03	61.05	743 00	759.63	759.63	61.05	-	-	743 00	123.15	2,725.64	87.924	1,844,434	19.5
April, . . .	364 50	390.39	38 33	34.50	622 10	671.44	671.44	34.50	-	-	702 00	122.12	2,124.74	70.825	1,326,890	28.3
May, . . .	332 10	337.69	33.99	28.39	744 00	775.52	775.52	28.39	10 45	9.91	744 00	121.96	2,285.69	73.732	1,346,380	33.6
June, . . .	107 30	117.82	31.88	30.17	567 00	594.81	594.81	30.17	461 30	501.77	720 00	121.74	2,368.82	78.961	1,319,575	30.4
July, . . .	-	-	-	33.12	364 05	365.10	365.10	28.49	744 00	787.29	739 30	121.79	2,330.74	75.185	1,400,236	23.4
August, . . .	21 15	21.11	34.27	30.41	585 15	600.65	600.65	29.24	637 05	649.42	744 00	122.10	2,467.81	79.607	1,619,558	26.1
September, . . .	-	-	-	34.38	193 00	174.74	174.74	28.03	679 40	655.97	720 00	121.54	2,001.40	66.713	1,338,220	18.1
October, . . .	38 25	29.36	35.34	34.87	86 10	86.38	86.38	27.95	632 45	641.66	637 30	122.30	1,948.48	62.854	1,301,792	19.5
November, . . .	-	-	-	36.60	43 05	37.86	37.86	27.99	714 30	742.58	720 00	121.68	1,889.31	62.977	1,212,343	23.0
December, . . .	-	-	-	34.67	159 35	154.09	154.09	28.39	630 35	640.65	744 00	121.86	1,979.55	63.856	1,325,945	24.1
Total, . . .	2,878 10	2,987.77	-	-	5,469 45	5,647.97	-	-	4,602 20	4,716.01	8,602 50	-	27,223.96	-	17,493,533	-
Average, . . .	-	-	45.38	37.66	-	-	-	28.82	-	-	-	122.44	-	74.586	-	24.1

TABLE No. 17. — *Statement of Operation of Engine No. 8 at Spot Pond Pumping Station for the Year 1918.*

Month.	Total Pumping Time.		Quantity pumped, 2 Per Cent. allowed for Slip (Million Gallons).	Coal consumed in pumping and banking (Pounds).	Ashes and Clincker (Pounds).	Per Cent. of Ashes and Clincker.	Gallons pumped per Pound of Coal, 2 Per Cent. allowed for Slip. No Deduction for Heating or Lighting.	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal, allowed for Heating or Lighting.	Duty in Foot-pounds on Basis of Plunger Displacement, No Deduction for Heating or Lighting.
	Hrs.	Min.								
January, . . . . .	.	.	.	.	.	.	.	.	.	.
February, . . . . .	.	.	.	.	.	.	.	.	.	.
March, . . . . .	.	.	.	.	.	.	.	.	.	.
April,	1	15	0.46	660	120	18.0	696.97	110.86	61,360,000	65,600,000
May, . . . . .	.	.	.	.	.	.	.	.	.	.
June, . . . . .	.	.	.	.	.	.	.	.	.	.
July, . . . . .	.	.	.	.	.	.	.	.	.	.
August, . . . . .	.	.	.	.	.	.	.	.	.	.
September, . . . . .	.	.	.	.	.	.	.	.	.	.
October, . . . . .	.	.	.	.	.	.	.	.	.	.
November,	179	35	77.45	114,495	20,590	18.0	676.45	122.78	69,180,000	70,610,000
December,	150	05	64.63	68,660	9,990	14.5	941.30	122.14	95,770,000	97,740,000
Total,	330	55	142.54	183,815	30,700	-	775.45	-	79,100,000	80,730,000
Average,	-	-	-	-	-	16.7	-	122.45	-	-

TABLE No. 18. — *Statement of Operation of Engine No. 9 at Spot Pond Pumping Station for the Year 1918.*

MONTH.	Total Pumping Time.	Quantity pumped, 2 Per Cent. allowed for Slip (Million Gallons).	Coal consumed in pumping and banking (Pounds).	Ashes and Clinker (Pounds).	Per Cent. of Ashes and Clinker.	Gallons pumped per Cent. allowed for Slip, No Deduction for Heating or Lighting.	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal, 2 Per Cent. allowed for Heating or Lighting.	Duty in Foot-pounds on Basis of Punter Displacement, No Deduction for Heating or Lighting.	SUMMARY OF ENGINES Nos. 8 and 9.	
										Total Quantity pumped, 2 Per Cent. allowed for Slip (Million Gallons).	Daily Average Quantity pumped, 2 Per Cent. allowed for Slip (Million Gallons).
January,	Hrs. Min. 358 30	298.62	354,614	71,675	20.2	841.82	132.49	92,910,000	94,800,000	298.52	9.630
February,	438 55	366.53	420,215	73,290	17.4	872.24	134.37	97,630,000	99,610,000	366.53	13.090
March,	413 00	347.47	400,848	74,895	18.7	866.84	134.55	97,160,000	99,130,000	347.47	11.209
April,	326 40	273.79	296,311	52,331	17.7	924.00	135.67	104,420,000	106,540,000	274.25	9.142
May,	343 55	288.71	312,240	58,090	18.6	924.64	131.50	101,280,000	103,340,000	288.71	9.313
June,	341 25	288.63	315,005	68,995	21.9	916.27	130.45	99,570,000	101,590,000	288.63	9.621
July,	370 55	311.09	344,300	65,380	19.0	903.54	129.83	97,720,000	99,700,000	311.09	10.035
August,	350 15	295.48	302,962	56,150	18.5	975.30	129.94	105,570,000	107,710,000	295.48	9.532
September,	320 20	267.29	306,398	61,535	20.1	872.36	130.15	91,580,000	96,500,000	267.29	8.910
October,	311 25	261.76	312,401	62,200	19.9	836.24	130.93	91,200,000	93,050,000	261.76	8.444
November,	193 15	161.05	206,030	34,745	16.9	781.68	132.95	86,570,000	88,330,000	238.50	7.950
December,	204 50	171.84	191,158	29,060	15.2	898.94	133.96	100,310,000	102,350,000	236.47	7.628
Total,	3,973 25	3,332.16	3,762,982	708,346	-	-	-	97,530,000	99,510,000	3,474.70	-
Average,	-	-	-	-	18.8	885.51	132.22	-	-	-	9.520

TABLE No. 19. — Statement of Operation of Engine No. 10 at Arlington Pumping Station for the Year 1918.

Month.	Total Pumping Time.		Quantity pumped, 2 Per Cent, allowed for Slip (Million Gallons).	Coal consumed in pumping and banking (Pounds).	Ashes and Clinker (Pounds).	Per Cent. of Ashes and Clinker.	Gallons pumped per Round of Coal, 2 Per Cent. allowed for Slip. No Deduction for Heating or Lighting.	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal, allowed for Slip. No Deduction for Heating or Lighting.	Duty in Foot-pounds on Basis of Plunger Displacement, No Deduction for Heating or Lighting.
	Hrs.	Min.								
January,	597	00	29.06	149,405	37,066	24.8	194.50	282.94	45,840,000	46,630,000
February,	617	30	35.78	155,785	37,728	24.2	229.68	288.89	55,270,000	56,230,000
March,	675	45	36.34	152,150	36,777	24.2	238.84	286.47	56,990,000	57,980,000
April,	603	15	30.33	154,244	36,817	23.9	196.64	281.91	46,180,000	46,980,000
May,	622	50	32.61	140,949	28,314	20.1	231.36	282.17	54,380,000	55,320,000
June,	603	00	32.48	123,850	24,088	19.4	262.25	283.32	61,890,000	62,960,000
July,	627	45	33.61	142,190	27,835	19.6	236.37	283.43	55,810,000	56,780,000
August,	637	00	33.48	157,124	25,481	16.2	213.08	280.01	49,700,000	50,560,000
September,	571	35	29.35	126,233	25,982	20.6	232.51	279.61	51,160,000	55,100,000
October,	688	05	26.41	114,185	19,699	17.2	231.29	278.12	53,580,000	54,510,000
November,	706	05	24.10	106,523	18,606	17.5	226.24	277.51	52,300,000	53,200,000
December,	721	00	24.13	126,990	34,185	26.9	190.01	277.43	43,910,000	44,670,000
Total,	7,700	50	367.68	1,649,628	352,578	-	-	-	-	-
Average,						21.4	222.89	282.20	52,400,000	53,310,000

TABLE No. 20. — Statement of Operation of Engine No. 11, at Arlington Pumping Station for the Year 1918.

[illegible]

TABLE No. 21. — Statement of Operation of Engine No. 15 and Summary of Engines at Arlington Pumping Station for the Year 1918.

Month.	Total Pumping Time.	Quantity pumped, Venturi Meter Measurement (Million Gallons).	Coal consumed in pumping and banking (Pounds).	Ashes and Clinker (Pounds).	Per Cent. of Ashes and Clinker.	Gallons pumped per Pound of Coal, Venturi Meter Measurement, No Deduction for Heating or Lighting.	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal, No Deduction for Heating or Lighting.	SUMMARY OF ENGINES Nos. 10, 11 AND 15.	
									Total Quantity pumped, Corrected for Slip (Million Gallons).	Daily Average Quantity pumped, Corrected for Slip (Million Gallons).
January,	Hrs. Min.	—	—	—	—	—	—	—	29.06	0.937
February,	—	—	—	—	—	—	—	—	35.78	1.278
March,	—	—	—	—	—	—	—	—	36.34	1.172
April,	—	—	—	—	—	—	—	—	30.33	1.011
May,	29 50	2.61	9,026	1,920	21.3	289.15	299.40	72,110,000 ¹	35.33	1.140
June,	76 15	3.89	24,015	7,350	30.6	161.94	280.90	37,890,000	36.37	1.212
July,	33 30	1.91	12,175	2,335	19.2	156.88	287.33	37,550,000	35.52	1.146
August,	—	—	—	—	—	—	—	—	33.48	1.080
September,	—	—	—	—	—	—	—	—	29.35	0.978
October,	—	—	—	—	—	—	—	—	26.41	0.852
November,	6 00	0.42	2,965	588	19.8	141.65	277.15	32,700,000	24.52	0.817
December,	—	—	—	—	—	—	—	—	24.13	0.778
Total,	145 35	8.83	48,181	12,193	—	—	—	—	376.62	—
Average,	—	—	—	—	25.3	183.27	287.59	43,900,000	—	1.032

¹ Duty trials, no heating or lighting.

TABLE No. 23. — (Meter Basis.) *Average Daily Consumption of Water by Districts in the Cities and Towns supplied by the Metropolitan Water Works in 1918. (For Consumption of Water in Whole Metropolitan Water District, see Table No. 25.)*

MONTH.	SOUTHERN LOW SERVICE.		NORTHERN LOW SERVICE.		SOUTHERN HIGH SERVICE.		NORTHERN HIGH SERVICE.		SOUTHERN EXTRA HIGH SERVICE.		NORTHERN EXTRA HIGH SERVICE.		Total District supplied (Gallons).	Estimated Population.	Consumption per Inhabitant (Gallons).
	Boston, excluding East Boston and Charlestown (Gallons).	Portions of Charlestown, Somerville, Chelsea, Everett, Malden, Medford, East Boston and Arlington (Gallons).	Quincy, Watertown, and Portions of Boston, Belmont and Milton (Gallons).	Revere, Winthrop, Swampscott, Nahant, Stoneham, Melrose, Boston, Chelsea, Everett, Malden, and Somerville (Gallons.)	Portions of Boston and Milton (Gallons).	Portions of Lexington and Portions of Arlington and Belmont (Gallons).									
January,	55,634,300	31,435,100	45,326,300	10,377,100	727,700	976,700	144,527,200	1,228,650	118						
February,	57,642,400	34,994,900	51,456,700	13,569,900	837,800	1,331,300	159,833,000	1,230,790	130						
March,	48,179,600	29,428,100	45,834,900	11,549,400	824,800	1,224,900	137,041,700	1,232,920	111						
April,	45,295,500	25,279,400	41,647,100	9,829,800	766,800	1,067,300	123,885,900	1,235,060	100						
May,	45,475,400	25,075,000	42,894,100	9,744,900	851,500	1,138,800	125,179,700	1,237,190	101						
June,	45,295,300	25,755,500	44,081,600	10,099,700	941,200	1,260,200	127,433,500	1,239,330	103						
July,	45,066,900	25,591,400	44,249,700	10,598,800	885,300	1,184,500	127,576,600	1,241,460	103						
August,	45,847,400	25,023,300	45,226,900	10,229,400	825,300	1,122,200	128,274,500	1,243,600	103						
September,	45,867,400	24,005,700	44,108,100	9,200,900	753,200	1,018,000	124,953,300	1,245,730	100						
October,	43,013,400	23,408,500	43,695,900	8,674,700	722,100	888,400	120,403,000	1,247,870	96						
November,	42,066,300	23,407,300	43,175,000	8,344,200	733,500	842,800	118,569,100	1,250,000	95						
December,	43,432,600	24,281,100	44,367,800	8,060,800	659,600	817,400	121,619,300	1,252,140	97						
For the year,	46,838,000	26,428,300	44,631,800	10,001,500	793,600	1,070,800	129,764,000	1,241,460	105						

In addition to the above quantities the United States Government Reservation on Peddock's Island was supplied with 49,246,000 gallons, equivalent to a daily average rate of 134,900 gallons, and a part of Saugus with 16,377,000 gallons, equivalent to a daily average rate of 44,900 gallons.

TABLE No. 24. — (Meter Basis.) *Average Daily Consumption of Water in Cities and Towns supplied by the Metropolitan Water Works in 1918.*

City or town, . . .	MONTH.	ABLINGTON.			BELMONT.			BOSTON.			CHELSEA.			EVERETT.			LEXINGTON.			MALDEN.		
		16,910.			9,330.			790,330.			47,570.			40,700.			5,900.			52,150.		
		GALLONS.			GALLONS.			GALLONS.			GALLONS.			GALLONS.			GALLONS.			GALLONS.		
		Per Day.	Per Capita.		Per Day.	Per Capita.		Per Day.	Per Capita.		Per Day.	Per Capita.		Per Day.	Per Capita.		Per Day.	Per Capita.		Per Day.	Per Capita.	
January,	1,121,100	68	.	534,400	58	.	107,582,900	137	.	4,306,700	92	.	4,582,700	114	.	451,700	77	.	3,065,400	59	.
February,	1,739,900	104	.	786,500	86	.	114,496,900	146	.	4,402,500	94	.	5,065,700	126	.	664,600	114	.	4,161,300	80	.
March,	1,646,500	99	.	628,200	68	.	97,096,100	124	.	3,708,000	79	.	3,803,700	94	.	622,900	106	.	4,208,000	81	.
April,	1,218,300	73	.	531,800	58	.	89,692,100	114	.	3,219,800	68	.	3,213,900	79	.	507,900	87	.	3,521,700	68	.
May,	1,326,400	79	.	577,700	62	.	90,897,800	115	.	3,302,300	70	.	3,064,300	76	.	540,700	92	.	3,270,200	63	.
June,	1,489,800	88	.	616,900	66	.	92,254,100	117	.	3,460,800	73	.	3,045,900	75	.	551,300	94	.	3,128,000	60	.
July,	1,419,200	84	.	572,300	61	.	92,368,900	117	.	3,681,200	77	.	3,058,300	75	.	527,700	89	.	3,112,400	60	.
August,	1,271,400	75	.	577,300	62	.	93,651,800	118	.	3,241,800	67	.	3,075,200	75	.	516,800	87	.	3,158,200	60	.
September,	1,167,200	69	.	569,100	61	.	92,453,500	117	.	3,190,100	67	.	3,019,600	74	.	451,400	76	.	3,085,000	59	.
October,	1,097,200	64	.	501,000	53	.	88,919,000	112	.	3,214,300	67	.	2,946,300	71	.	382,200	64	.	2,944,200	56	.
November,	999,000	58	.	523,400	55	.	86,947,300	109	.	3,153,600	66	.	2,790,900	68	.	375,000	63	.	2,784,200	53	.
December,	1,022,400	60	.	531,800	56	.	90,611,800	114	.	3,218,600	67	.	2,872,200	70	.	356,900	60	.	2,680,000	51	.
For the year,	1,290,300	76	.	577,700	62	.	94,634,000	120	.	3,501,200	74	.	3,365,800	83	.	404,600	84	.	3,254,700	62	.

TABLE No. 24. — *Average Daily Consumption of Water in Cities and Towns, etc. — Continued.*

City or town,	MEDFORD.				MELROSE.		MILTON.		NAHANT.		QUINCY.		REVERE.			
	34,600.				17,870.		9,250.		1,539.		44,200.		29,350.			
	GALLONS.				GALLONS.		GALLONS.		GALLONS.		GALLONS.		GALLONS.			
MONTH.	Per Day.		Per Capita.		Per Day.		Per Capita.		Per Day.		Per Capita.		Per Day.		Per Capita.	
	Per Day.		Per Capita.		Per Day.		Per Capita.		Per Day.		Per Capita.		Per Day.		Per Capita.	
January,	2,027,900	60	1,237,500	70	425,100	46	142,200	94	3,862,000	88	2,393,500	83				
February,	3,127,000	92	1,918,600	108	557,900	61	183,900	122	4,554,700	104	2,912,100	101				
March,	2,762,100	81	1,424,400	80	541,700	59	209,500	138	4,945,100	113	2,171,300	75				
April,	2,240,300	65	1,110,800	62	449,300	49	135,100	89	4,451,000	101	1,728,500	60				
May,	2,162,000	63	1,198,400	67	471,100	51	216,200	142	4,440,000	101	1,863,000	64				
June,	2,324,900	67	1,164,600	65	513,000	56	360,400	233	4,471,700	101	1,925,400	66				
July,	2,194,400	63	1,083,400	61	425,400	46	398,900	261	4,665,100	106	2,068,300	70				
August,	2,141,900	62	1,060,500	59	363,200	39	422,900	276	4,838,800	109	2,162,600	73				
September,	1,882,500	54	1,035,900	58	360,500	39	288,700	187	4,588,200	103	1,763,400	61				
October,	1,814,700	52	991,600	55	379,500	41	191,600	124	4,690,600	105	1,614,900	54				
November,	1,693,400	48	1,004,600	56	374,400	40	104,900	68	5,015,700	113	1,548,900	52				
December,	1,640,500	47	995,200	55	364,100	39	79,400	51	5,054,200	113	1,585,200	53				
For the year,	2,161,200	62	1,180,600	66	434,500	47	228,200	149	4,632,100	105	1,975,500	67				

TABLE No. 24. — *Average Daily Consumption of Water in Cities and Towns, etc.* — Concluded.

City or town,	MONTH.	SOMERVILLE.			STONEHAM.			SWAMPSCOTT.			WATERTOWN.			WINTHROP.			METROPOLITAN DISTRICT.		
		92,930.			7,760.			7,960.			18,520.			14,600.			1,241,460.		
		GALLONS.		Per Capita.	GALLONS.		Per Capita.	GALLONS.		Per Capita.	GALLONS.		Per Capita.	GALLONS.		Per Capita.	GALLONS.		Per Capita.
		Per Day.			Per Day.			Per Day.			Per Day.			Per Day.			Per Day.		
January,	.	8,870,200	.	96	675,400	.	87	498,800	.	63	1,971,100	.	108	778,600	.	54	144,527,200	.	118
February,	.	9,530,000	.	103	1,160,500	.	151	685,300	.	87	2,506,900	.	137	1,372,700	.	96	159,833,000	.	130
March,	.	8,215,000	.	89	989,700	.	128	579,300	.	73	2,307,800	.	126	1,182,400	.	82	137,041,700	.	111
April,	.	7,414,800	.	80	778,900	.	101	698,500	.	88	1,987,200	.	108	983,000	.	68	123,885,900	.	100
May,	.	7,398,300	.	80	558,900	.	72	581,700	.	73	2,339,700	.	127	971,000	.	67	125,179,700	.	101
June,	.	7,554,900	.	81	508,200	.	66	691,800	.	87	2,110,600	.	131	961,200	.	66	127,433,500	.	103
July,	.	7,156,100	.	77	507,100	.	65	700,000	.	88	2,561,600	.	138	1,073,300	.	74	127,576,600	.	103
August,	.	6,832,200	.	73	474,100	.	61	726,500	.	91	2,730,300	.	147	1,055,700	.	72	128,274,500	.	103
September,	.	6,633,300	.	71	446,300	.	58	608,800	.	76	2,550,500	.	137	828,700	.	56	124,953,300	.	100
October,	.	6,572,600	.	70	439,200	.	56	566,600	.	71	2,447,800	.	131	719,700	.	49	120,403,000	.	96
November,	.	6,670,800	.	71	457,000	.	59	510,600	.	64	2,886,900	.	154	718,900	.	49	118,569,100	.	95
December,	.	6,497,800	.	69	453,400	.	58	435,200	.	54	2,523,600	.	134	691,000	.	47	121,619,300	.	97
For the year,	.	7,433,200	.	80	617,700	.	80	608,100	.	76	2,434,700	.	131	941,900	.	65	129,764,000	.	105

TABLE No. 25. — Consumption of Water in the Metropolitan Water District, as constituted in the Year 1918, and a Small Section of the Town of Saugus, from 1893 to 1918.

[Gallons per Day.]

MONTH.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.
January,	75,209,000	67,506,000	68,925,000	82,946,000	85,366,000	83,880,000	96,442,000	100,055,000	111,275,000
February,	71,900,000	68,944,000	80,375,000	87,021,000	83,967,000	87,475,000	103,454,000	98,945,000	117,497,000
March,	67,638,000	62,710,000	69,543,000	86,111,000	82,751,000	85,468,000	90,200,000	97,753,000	105,509,000
April,	62,309,000	57,715,000	62,909,000	77,529,000	79,914,000	76,574,000	86,491,000	89,497,000	93,317,000
May,	61,025,000	60,676,000	65,194,000	73,402,000	76,772,000	76,677,000	89,448,000	87,780,000	95,567,000
June,	63,374,000	68,329,000	69,905,000	77,639,000	77,952,000	83,463,000	97,691,000	98,581,000	103,420,000
July,	69,343,000	73,642,000	69,667,000	80,000,000	85,525,000	88,228,000	96,821,000	107,786,000	106,905,000
August,	66,983,000	67,993,000	72,233,000	78,537,000	84,103,000	87,558,000	92,072,000	102,717,000	102,815,000
September,	64,654,000	67,137,000	73,724,000	74,160,000	81,296,000	88,296,000	91,478,000	103,612,000	102,103,000
October,	63,770,000	62,735,000	67,028,000	71,762,000	79,551,000	81,770,000	89,580,000	98,358,000	103,389,000
November,	61,204,000	62,231,000	64,881,000	71,933,000	72,762,000	78,177,000	86,719,000	93,648,000	101,324,000
December,	66,700,000	65,108,000	70,443,000	79,149,000	76,594,000	86,355,000	85,840,000	97,844,000	113,268,000
Average,	66,165,000	65,382,000	69,499,000	78,360,000	80,793,000	83,651,000	92,111,000	98,059,000	104,645,000
Population,	724,180	744,720	765,430	787,880	810,340	832,790	855,250	877,700	892,740
Per capita,	91.4	87.8	90.8	99.5	99.7	100.4	107.7	111.7	117.2

See note at end of this table.

TABLE No. 25. — *Consumption of Water, etc.* — Continued.
[Gallons per Day.]

MONTH.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.
January,	118,435,000	125,176,000	137,771,000	130,878,000	126,093,000	137,730,000	132,376,000	133,275,000	127,568,000
February,	117,268,000	122,728,000	143,222,000	140,505,000	130,766,000	150,822,000	146,199,000	130,763,000	131,093,000
March,	108,461,000	111,977,000	123,334,000	120,879,000	123,570,000	134,202,000	128,884,000	126,842,000	117,078,000
April,	103,153,000	107,179,000	108,683,000	111,898,000	118,428,000	121,556,000	128,926,000	125,335,000	112,775,000
May,	106,692,000	111,589,000	111,715,000	115,804,000	122,404,000	123,502,000	131,040,000	123,305,000	112,073,000
June,	110,002,000	105,590,000	111,209,000	117,441,000	121,882,000	125,623,000	139,843,000	125,179,000	114,082,000
July,	108,340,000	107,562,000	113,584,000	124,769,000	118,726,000	128,779,000	138,232,000	126,765,000	122,743,000
August,	107,045,000	103,570,000	112,836,000	121,158,000	120,591,000	131,098,000	128,073,000	121,781,000	118,373,000
September,	107,752,000	106,772,000	114,188,000	120,103,000	121,685,000	124,751,000	129,972,000	118,043,000	112,434,000
October,	106,560,000	103,602,000	108,290,000	118,301,000	116,561,000	124,031,000	124,189,000	115,939,000	112,332,000
November,	105,175,000	103,477,000	108,054,000	116,693,000	113,746,000	119,627,000	117,119,000	111,664,000	107,528,000
December,	125,434,000	114,721,000	125,119,000	122,696,000	130,995,000	122,407,000	124,468,000	115,733,000	121,994,000
Average,	110,345,000	110,277,000	118,114,000	121,671,000	122,085,000	128,561,000	130,712,000	122,851,000	117,458,000
Population,	907,780	922,820	937,860	955,920	981,720	1,007,520	1,025,890	1,051,420	1,077,090
Per capita,	121.6	119.5	125.9	127.3	124.4	127.6	127.4	116.8	109.1

See note at end of this table.

TABLE No. 25. — *Consumption of Water, etc.* — Concluded.
[Gallons per day.]

MONTH.	1911.	1912.	1913.	1914.	1915.	1916.	1917.	1918.
January,	123,281,000	137,277,000	113,489,000	117,337,000	109,689,000	110,202,000	115,416,000	146,582,000
February,	124,359,000	141,440,000	120,713,000	127,083,000	108,361,000	112,338,000	120,840,000	156,628,000
March,	116,669,000	122,804,000	107,871,000	110,105,000	102,241,000	109,944,000	109,068,000	140,078,000
April,	111,656,000	113,308,000	104,086,000	103,609,000	98,055,000	100,326,000	102,817,000	125,975,000
May,	118,005,000	114,548,000	104,311,000	105,821,000	98,940,000	103,940,000	102,883,000	126,139,000
June,	114,145,000	118,793,000	108,193,000	114,165,000	104,252,000	103,349,000	106,043,000	128,152,000
July,	123,052,000	120,261,000	112,084,000	106,233,000	101,074,000	106,332,000	113,344,000	127,289,000
August,	111,091,000	112,968,000	106,660,000	105,786,000	101,331,000	110,090,000	114,870,000	128,642,000
September,	108,726,000	112,352,000	105,449,000	109,873,000	108,043,000	108,691,000	109,467,000	125,352,000
October,	106,873,000	110,220,000	103,756,000	105,241,000	103,622,000	108,008,000	107,104,000	121,798,000
November,	105,373,000	109,289,000	101,441,000	101,228,000	101,474,000	103,835,000	103,892,000	119,242,000
December,	104,592,000	110,114,000	102,480,000	108,741,000	102,074,000	106,777,000	120,326,000	122,502,000
Average,	113,951,000	118,546,000	107,466,000	109,489,000	103,227,000	106,994,000	110,475,000	130,551,000
Population,	1,103,290	1,129,500	1,155,710	1,181,920	1,208,160	1,234,460	1,260,760	1,287,050
Per capita,	103.3	105.0	93.0	92.6	85.4	86.7	87.6	101.4

This table includes the water consumed in the cities and towns enumerated in Table No. 24, together with the water consumed in Newton, which is included in the Metropolitan Water District but has not been supplied from the Metropolitan Works, and a small section of the town of Saugus.
From 1893 to 1903, inclusive, consumption based on pumpage. Since 1903, portion of supply delivered by gravity and measured by meters.

TABLE No. 26. — *Chemical Examinations of Water from the Wachusett Reservoir, Clinton.*
[Parts per 100,000.]

Number.	Date of Collection.	APPEARANCE.			Odor.	RESIDUE ON EVAPORATION.			AMMONIA.				Chlorine.	Hardness.
		Turbidity.	Sediment.	Color.		Total.	Loss on Ignition.	Free.	Total.	ALUMINOID.				
										Dissolved.	Suspended.			
33974	Jan. 1	None.	V. slight.	.15	V. faintly vegetable.	Faintly vegetable.	3.65	1.60	.0014	.0116	.0100	.0016	.27	1.1
40027	Jan. 8	V. slight.	V. slight.	.12	V. faintly vegetable.	V. faintly vegetable.	3.00	1.50	.0020	.0090	.0078	.0012	.29	1.0
40160	Jan. 22	None.	V. slight.	.11	V. faintly vegetable.	V. faintly vegetable.	3.55	1.35	.0046	.0120	.0096	.0024	.29	1.1
40318	Feb. 5	None.	V. slight.	.12	V. faintly vegetable.	V. faintly vegetable.	3.35	1.10	.0020	.0120	.0096	.0024	.31	1.1
40588	Feb. 26	V. slight.	None.	.15	V. faintly vegetable.	V. faintly vegetable.	4.30	1.20	.0026	.0090	.0088	.0002	.28	1.1
40721	Mar. 12	V. slight.	V. slight.	.24	V. faintly vegetable.	Faintly vegetable.	3.55	1.75	.0038	.0144	.0128	.0016	.27	1.0
40928	Mar. 26	V. slight.	V. slight.	.20	V. faintly vegetable.	Faintly vegetable.	3.10	1.00	.0020	.0100	.0094	.0006	.30	1.3
41069	Apr. 9	V. slight.	V. slight.	.12	None.	V. faintly unpleasant.	3.05	1.50	.0020	.0152	.0142	.0010	.28	1.0
41373	May 14	V. slight.	V. slight.	.15	V. faintly vegetable.	Faintly vegetable.	3.30	1.05	.0014	.0136	.0116	.0020	.27	1.0
41482	May 21	None.	V. slight.	.19	V. faintly vegetable.	Faintly vegetable.	3.30	1.05	.0018	.0118	.0102	.0016	.28	1.0
41679	June 4	V. slight.	V. slight.	.14	V. faintly vegetable.	Faintly vegetable.	3.30	1.10	.0024	.0132	.0122	.0010	.28	1.3
41958	June 18	V. slight.	V. slight.	.15	Faintly vegetable.	Distinctly vegetable.	3.70	1.25	.0068	.0146	.0130	.0016	.28	1.3
42342	July 16	V. slight.	V. slight.	.16	V. faintly vegetable.	V. faintly vegetable.	3.45	1.20	.0020	.0162	.0140	.0022	.32	1.1
42524	July 24	None.	V. slight.	.15	V. slight vegetable.	Slight vegetable.	3.45	1.20	.0020	.0136	.0120	.0016	.27	1.1
42744	Aug. 6	V. slight.	V. slight.	.15	Faintly vegetable and sweetish.	Distinctly vegetable and sweetish.	2.95	0.80	.0030	.0162	.0140	.0022	.26	1.0
43027	Aug. 20	V. slight.	V. slight.	.14	V. faintly vegetable.	V. faintly vegetable.	3.00	1.00	.0012	.0120	.0110	.0010	.30	1.1
43294	Sept. 10	V. slight.	V. slight.	.13	V. faintly vegetable.	V. faintly vegetable.	2.45	1.10	.0014	.0166	.0146	.0020	.36	1.3
43577	Sept. 25	None.	V. slight.	.13	V. faintly vegetable.	Faintly vegetable.	2.70	1.00	.0028	.0120	.0092	.0028	.32	1.7
43694	Oct. 8	None.	V. slight.	.15	V. faintly vegetable and cucumber.	Faintly vegetable and cucumber.	2.90	1.20	.0026	.0120	.0094	.0008	.26	1.0
43960	Oct. 29	V. slight.	None.	.12	V. faintly vegetable.	V. faintly vegetable.	3.05	1.00	.0022	.0094	.0090	.0004	.29	1.3
44245	Nov. 19	V. slight.	V. slight.	.12	V. faintly vegetable.	V. faintly vegetable.	2.00	0.80	.0024	.0070	.0064	.0006	.34	1.1
44524	Dec. 10	V. slight.	V. slight.	.11	V. faintly vegetable.	V. faintly vegetable.	3.35	1.00	.0028	.0194	.0182	.0012	.36	1.0
44703	Dec. 23	V. slight.	V. slight.	.11	V. faintly vegetable.	V. faintly vegetable.	3.30	1.25	.0026	.0150	.0138	.0012	.38	1.3
Av.	.....	.....	.....	.18	.....	.....	3.24	1.17	.0025	.0127	.0113	.0014	.29	1.1

TABLE No. 27. — *Chemical Examinations of Water from the Sudbury Reservoir.*
[Parts per 100,000.]

Number.	Date of Collection.	APPEARANCE.			Odor.		RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	Hardness.
		Turbidity.	Sediment.	Color.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	ALBUMINOID.				
										Total.	Dissolved.	Suspended.		
140009	Jan. 7	None.	V. slight.	.14	V. faintly vegetable.	Faintly vegetable.	4.50	1.95	.0010	.0126	.0118	.0008	.32	1.3
140338	Feb. 5	None.	V. slight.	.17	V. faintly vegetable.	Faintly vegetable.	3.70	1.00	.0026	.0120	.0100	.0020	.30	1.3
140637	Mar. 5	V. slight.	V. slight.	.18	V. faintly vegetable.	Faintly vegetable.	3.75	1.70	.0052	.0142	.0124	.0018	.36	1.0
141007	Apr. 1	V. slight.	V. slight.	.24	Faintly vegetable.	Faintly vegetable.	3.75	1.80	.0076	.0180	.0140	.0040	.32	1.1
141250	May 6	V. slight.	Slight.	.25	V. faintly vegetable.	Faintly vegetable.	3.50	1.05	.0018	.0158	.0134	.0024	.32	1.0
141350	May 10	V. slight.	V. slight.	.20	Faintly vegetable.	Distinctly vegetable.	3.25	1.35	.0026	.0168	.0144	.0024	.32	1.0
141664	June 3	V. slight.	V. slight.	.20	Faintly vegetable.	Distinctly vegetable.	4.10	1.75	.0012	.0172	.0132	.0040	.33	1.4
142208	July 9	V. slight.	V. slight.	.16	V. faintly vegetable.	Faintly vegetable.	3.15	1.20	.0024	.0186	.0150	.0036	.32	1.4
142791	Aug. 9	V. slight.	V. slight.	.11	V. faintly vegetable.	V. faintly vegetable.	4.05	2.00	.0050	.0172	.0152	.0020	.29	1.3
143198	Sept. 4	V. slight.	None.	.17	Faintly vegetable and unpleasant.	Distinctly vegetable and unpleasant.	3.20	1.15	.0022	.0112	.0100	.0012	.32	1.3
143681	Oct. 7	V. slight.	V. slight.	.12	V. faintly vegetable.	V. faintly vegetable.	3.55	1.00	.0050	.0098	.0060	.0038	.32	1.3
144045	Nov. 5	V. slight.	V. slight.	.15	V. faintly vegetable.	V. faintly vegetable.	3.50	1.00	.0032	.0106	.0090	.0016	.32	1.6
144570	Dec. 16	V. slight.	V. slight.	.21	V. faintly vegetable.	Faintly vegetable.	3.60	1.40	.0034	.0148	.0140	.0008	.39	1.4
Av.	.....	.....	.....	.17	.....	.....	3.66	1.41	.0033	.0145	.0121	.0023	.32	1.2

TABLE No. 28. — *Chemical Examinations of Water from Spot Pond, Stonham.*
[Parts per 100,000.]

Number.	Date of Collection.	APPEARANCE.			Odor.		RESIDUE ON EVAPORATION.		AMMONIA.			Chlorine.	Hardness.	
		Turbidity.	Sediment.	color.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	ALBUMINOID.				
										Total.	Dissolved.			Suspended.
140135	Jan. 21	None.	V. slight.	.10	V. faintly unpleasant and fishy.	Faintly unpleasant and fishy.	4.50	1.70	.0024	.0172	.0130	.0042	.36	1.4
140348	Feb. 11	V. slight.	None.	.15	V. faintly vegetable.	V. faintly vegetable.	3.60	1.20	.0046	.0162	.0128	.0034	.35	1.4
140619	Mar. 1	None.	None.	.14	V. faintly vegetable.	Faintly vegetable.	3.50	1.45	.0020	.0156	.0128	.0028	.35	1.6
140988	Apr. 1	V. slight.	V. slight.	.15	Faintly vegetable and unpleasant.	Faintly vegetable and unpleasant.	4.00	1.30	.0006	.0164	.0128	.0036	.36	1.3
141353	May 13	V. slight.	Slight.	.21	Faintly unpleasant and fishy.	Distinctly unpleasant and fishy.	3.60	1.00	.0004	.0176	.0140	.0036	.28	1.3
141789	June 10	V. slight.	V. slight.	.10	Faintly vegetable and earthy.	Distinctly vegetable and earthy.	3.45	1.15	.0018	.0244	.0180	.0064	.32	1.0
142310	July 15	None.	V. slight.	.10	V. faintly vegetable and unpleasant.	Faintly vegetable and unpleasant.	3.50	1.25	.0008	.0162	.0146	.0016	.36	1.4
142960	Aug. 19	V. slight.	V. slight.	.12	V. faintly vegetable.	Faintly vegetable.	3.60	1.35	.0016	.0158	.0120	.0038	.39	1.3
143315	Sept. 10	None.	V. slight.	.10	V. faintly vegetable.	Faintly vegetable.	3.20	1.00	.0024	.0140	.0122	.0018	.37	1.3
144005	Nov. 4	V. slight.	V. slight.	.10	Faintly vegetable.	Distinctly vegetable.	3.70	1.20	.0022	.0176	.0170	.0006	.42	1.6
144563	Dec. 16	V. slight.	V. slight.	.11	V. faintly vegetable.	Faintly vegetable.	3.80	1.65	.0032	.0182	.0166	.0016	.38	1.3
Av.	.....	.....	.....	.12	.....	.....	3.67	1.29	.0020	.0172	.0141	.0030	.35	1.3

TABLE No. 29. — *Chemical Examinations of Water from Lake Cochituate.*
[Parts per 100,000.]

Number.	Date of Collection.	APPEARANCE.			ODOR.		RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	Hardness.
		Turbidity.	Sediment.	COLOR. Platinum Standard.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	ALBUMINOID.				
										Total.	Dissolved.	Suspended.		
139992	Jan. 7	V. slight.	V. slight.	.17	V. faintly vegetable.	Faintly vegetable.	6.25	2.10	.0060	.0230	.0188	.0042	.76	3.0
140307	Feb. 4	V. slight.	V. slight.	.20	V. faintly vegetable and earthy.	Faintly vegetable and earthy.	7.15	3.45	.0054	.0234	.0160	.0074	.76	2.6
140635	Mar. 5	V. slight.	V. slight.	.28	V. faintly vegetable.	Faintly vegetable.	6.30	3.00	.0046	.0264	.0166	.0098	.74	2.3
141004	Apr. 1	V. slight.	V. slight.	.26	Faintly vegetable.	Distinctly vegetable.	6.85	3.35	.0024	.0302	.0194	.0108	.63	2.0
141257	May 6	Slight.	Slight.	.25	Faintly vegetable.	Distinctly vegetable.	6.00	2.50	.0010	.0308	.0164	.0144	.68	3.0
141661	June 3	Slight.	Slight.	.18	Distinctly vegetable and earthy.	Decidedly vegetable and earthy.	6.15	1.55	.0008	.0296	.0194	.0102	.74	2.1
142204	July 9	V. slight.	V. slight.	.18	Faintly vegetable and unpleasant.	Faintly vegetable and unpleasant.	5.70	1.55	.0012	.0288	.0238	.0050	.76	2.6
142715	Aug. 6	V. slight.	V. slight.	.18	Faintly vegetable.	Faintly vegetable.	7.20	2.05	.0022	.0264	.0242	.0022	.68	2.3
143202	Sept. 4	V. slight.	None.	.12	Faintly vegetable and earthy.	Distinctly vegetable and earthy.	6.30	2.20	.0022	.0194	.0178	.0016	.76	2.6
143667	Oct. 3	Slight.	Slight.	.15	Faintly vegetable and earthy.	Distinctly vegetable and earthy.	5.90	1.65	.0008	.0254	.0178	.0076	.80	2.5
144012	Nov. 4	Slight.	V. slight.	.20	Faintly vegetable and earthy.	Distinctly vegetable and earthy.	6.45	1.50	.0008	.0270	.0196	.0074	.74	2.2
144542	Dec. 12	Slight.	V. slight.	.25	Faintly unpleasant and earthy.	Distinctly unpleasant and earthy.	5.85	2.50	.0088	.0254	.0192	.0062	.78	2.6
Av.	.....	.....	.....	.20	.....	.....	6.34	2.28	.0030	.0263	.0190	.0072	.73	2.4

TABLE No. 30. — *Chemical Examinations of Water from a Tap at the State House, Boston.*
[Parts per 100,000.]

Number.	Date of Collection.	APPEARANCE.			Odor.		RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	Hardness.
		Turbidity.	Sediment.	COLOR.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		
140000	Jan. 9	V. slight.	V. slight.	.19	V. faintly fishy.	Faintly fishy.	3.55	1.80	.0012	.0158	.0118	.0040	.35	1.4
140404	Feb. 13	V. slight.	V. slight.	.12	Faintly vegetable.	Faintly vegetable.	4.50	1.45	.0016	.0120	.0094	.0026	.35	1.7
140614	Mar. 4	V. slight.	V. slight.	.20	V. faintly vegetable and unpleasant.	Faintly vegetable and unpleasant.	3.80	1.00	.0024	.0132	.0122	.0010	.30	1.3
140989	Apr. 1	V. slight.	V. slight.	.22	V. faintly vegetable.	Faintly vegetable.	4.75	2.00	.0036	.0152	.0134	.0018	.36	1.6
141354	May 13	V. slight.	Slight.	.21	Faintly unpleasant and fishy.	Distinctly unpleasant and fishy.	3.60	1.20	.0014	.0228	.0172	.0056	.34	1.6
141650	June 3	Slight.	V. slight.	.20	Faintly vegetable and unpleasant.	Distinctly vegetable and unpleasant.	3.80	1.35	.0012	.0174	.0126	.0048	.32	1.6
142717	Aug. 7	V. slight.	V. slight.	.20	V. faintly vegetable.	Faintly vegetable.	4.20	1.30	.0026	.0142	.0136	.0006	.30	1.6
143150	Sept. 3	V. slight.	V. slight.	.11	V. faintly vegetable.	Faintly vegetable.	3.30	1.25	.0018	.0178	.0132	.0046	.30	1.3
143737	Oct. 16	V. slight.	V. slight.	.22	V. faintly vegetable.	Faintly vegetable.	3.40	1.55	.0008	.0124	.0120	.0004	.32	1.3
144669	Dec. 23	V. slight.	V. slight.	.21	V. faintly vegetable.	V. faintly vegetable.	4.00	1.60	.0024	.0136	.0126	.0010	.32	1.4
Av.	.....	.....	.....	.18	.....	.....	3.89	1.45	.0019	.0154	.0128	.0026	.29	1.4

TABLE No. 31. — *Averages of Chemical Examinations of Water from Various Parts of the Metropolitan Water Works in 1918.*
[Parts per 100,000.]

LOCALITY.	Samples collected.	COLOR.	RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	Hardness.	
			Platinum Standard.	Total.	Loss on Ignition.	Free.	ALBUMINOID.				
							Total.	Dissolved.			Suspended.
Quinepoxet River, Holden, ¹	.	47	4.78	1.89	.0033	.0198	.0161	.0030	.49	1.0	
Stillwater River, Sterling, ²	.	32	3.77	1.37	.0029	.0189	.0122	.0018	.24	1.0	
Wachusett Reservoir, West Poylston, ³	.	27	4.18	1.56	.0026	.0147	.0118	.0022	.33	1.3	
Wachusett Reservoir, Clinton, surface, ³	.	18	3.24	1.17	.0025	.0127	.0113	.0014	.29	1.1	
Wachusett Reservoir, Clinton, bottom,	.	15	3.28	1.27	.0026	.0103	.0095	.0008	.29	1.1	
Marlborough (Walker's Brook),	.	58	18.37	5.40	.0789	.0382	.0298	.0083	2.97	6.5	
Marlborough Brook filter beds, effluent, ⁴	.	10	14.37	—	.0043	.0108	—	—	2.15	5.0	
Wachusett Aqueduct, Southborough,	.	16	3.52	1.30	.0021	.0131	.0116	.0014	.31	1.2	
Sudbury Reservoir, surface,	.	17	3.66	1.41	.0033	.0145	.0121	.0023	.32	1.2	
Sudbury Reservoir, bottom,	.	18	3.42	1.25	.0049	.0140	.0124	.0016	.32	1.2	
Framingham Reservoir No. 3, inlet, ⁴	.	26	3.94	1.56	.0038	.0164	.0143	.0021	.32	1.4	
Framingham Reservoir No. 3, near dam,	.	18	3.80	1.33	.0031	.0163	.0133	.0030	.31	1.3	
Hopkinton Reservoir, inlet, ⁵	.	74	5.12	2.02	.0034	.0284	.0244	.0040	.43	1.2	
Hopkinton Reservoir, surface,	.	53	4.06	1.69	.0037	.0215	.0172	.0033	.33	1.2	
Hopkinton Reservoir, bottom,	.	60	4.67	1.86	.0048	.0213	.0175	.0022	.41	1.2	
Ashland Reservoir, inlet,	.	1.23	6.72	2.89	.0057	.0341	.0302	.0039	.43	1.5	
Ashland Reservoir, surface,	.	61	4.27	1.80	.0035	.0236	.0211	.0025	.37	1.3	
Ashland Reservoir, bottom,	.	57	4.43	1.87	.0039	.0228	.0187	.0042	.36	1.4	
Framingham Reservoir No. 2, inlet, ⁴	.	76	5.55	2.12	.0535	.0282	.0247	.0045	.47	1.4	
Framingham Reservoir No. 2, near dam,	.	70	5.03	2.19	.0039	.0266	.0232	.0034	.44	1.5	
Lake Cochituate, surface,	.	20	6.34	2.28	.0030	.0263	.0190	.0072	.73	2.4	
Lake Cochituate, bottom, ⁵	.	48	6.89	2.59	.0610	.0290	.0201	.0089	.72	2.6	
Weston Reservoir, ⁵	.	18	3.49	1.30	.0029	.0164	.0128	.0036	.33	1.4	
Terminal chamber, Sudbury Aqueduct,	.	18	3.67	1.26	.0023	.0244	.0123	.0021	.33	1.4	
Spot Pond, ⁵	.	12	3.67	1.29	.0020	.0172	.0141	.0030	.35	1.3	
Tap in Revere,	.	10	3.70	1.29	.0014	.0132	.0097	.0015	.23	1.4	
Tap at State House, ⁶	.	18	3.89	1.45	.0019	.0154	.0128	.0026	.29	1.4	
Tap in Quincy,	.	16	3.69	1.30	.0015	.0119	.0098	.0009	.33	1.4	

¹ Averages of 22 samples.² Averages of 21 samples.³ Averages of 23 samples.⁴ Averages of 6 samples.⁵ Averages of 11 samples.⁶ Averages of 10 samples.

TABLE NO. 32. — *Chemical Examinations of Water from a Faucet in Boston, from 1892 to 1918.*

[Parts per 100,000.]

YEAR.	COLOR.	RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	Oxygen consumed.	Hardness.
	Platinum Standard.	Total.	Loss on Ignition.	Free.	ALBUMINOID.					
					Total.	Dissolved.	Suspended.			
1892, . . . . .	.37	4.70	1.67	.0007	.0168	.0138	.0030	.41	-	1.9
1893, . . . . .	.53	4.54	1.84	.0010	.0174	.0147	.0027	.38	.60	1.8
1894, . . . . .	.58	4.64	1.83	.0006	.0169	.0150	.0019	.41	.63	1.7
1895, . . . . .	.59	4.90	2.02	.0006	.0197	.0175	.0022	.40	.69	0.7
1896, . . . . .	.45	4.29	1.57	.0005	.0165	.0142	.0023	.37	.56	1.4
1897, . . . . .	.55	4.82	1.84	.0009	.0193	.0177	.0016	.40	.64	1.6
1898, . . . . .	.40	4.19	1.60	.0008	.0152	.0135	.0015	.29	.44	1.4
1899, . . . . .	.28	3.70	1.39	.0006	.0136	.0122	.0014	.24	.35	1.1
1900, . . . . .	.29	3.80	1.20	.0012	.0157	.0139	.0018	.25	.38	1.3
1901, . . . . .	.29	4.43	1.64	.0013	.0158	.0142	.0016	.30	.42	1.7
1902, . . . . .	.30	3.93	1.56	.0016	.0139	.0119	.0020	.29	.40	1.3
1903, . . . . .	.29	3.98	1.50	.0013	.0125	.0110	.0015	.30	.39	1.5
1904, . . . . .	.23	3.93	1.59	.0023	.0139	.0121	.0018	.34	.37	1.5
1905, . . . . .	.24	3.86	1.59	.0020	.0145	.0124	.0021	.35	.35	1.4
1906, . . . . .	.24	3.86	1.39	.0018	.0159	.0134	.0025	.34	.35	1.3
1907, . . . . .	.22	3.83	1.40	.0013	.0129	.0109	.0020	.33	.32	1.3
1908, . . . . .	.19	3.50	1.35	.0011	.0115	.0092	.0024	.33	.26	1.2
1909, . . . . .	.18	3.46	1.43	.0011	.0128	.0103	.0025	.28	.25	1.3
1910, . . . . .	.14	3.05	1.24	.0013	.0118	.0102	.0016	.28	.22	1.1
1911, . . . . .	.25	4.18	1.66	.0015	.0156	.0128	.0029	.38	.33	1.4
1912, . . . . .	.17	3.56	1.23	.0018	.0154	.0119	.0034	.36	.29	1.7
1913, . . . . .	.13	3.96	1.15	.0014	.0150	.0120	.0026	.35	.26	1.5
1914, . . . . .	.14	4.12	1.19	.0014	.0138	.0116	.0022	.39	.25	1.4
1915, . . . . .	.16	3.73	1.04	.0015	.0157	.0134	.0023	.38	.25	1.4
1916, . . . . .	.18	4.53	1.85	.0013	.0133	.0107	.0026	.36	-	1.4
1917, . . . . .	.15	4.45	1.68	.0015	.0142	.0124	.0018	.33	-	1.3
1918, . . . . .	.18	3.89	1.45	.0019	.0154	.0128	.0026	.29	-	1.4

TABLE No. 33. — *Microscopic Organisms in Water from Various Parts of the Metropolitan Water Works, from 1898 to 1918, inclusive.*

[Standard units per cubic centimeter; averages from weekly or biweekly observations.]

YEAR.	WACHUSETT RESERVOIR.		SUDBURY RESERVOIR.		LAKE COCHITUATE.		FRAMINGHAM RESERVOIR. No. 3.		FRAMINGHAM RESERVOIR. No. 2.		ASHLAND RESERVOIR.		HOPKINTON RESERVOIR.		WHITEHALL RESERVOIR.	
	Surface.	Bottom.	Surface.	Bottom.	Surface.	Bottom.	Surface.	Bottom.	Mid-depth.	Surface.	Surface.	Surface.	Surface.	Surface.	Surface.	Surface.
1898,	-	-	354	149	830	696	390		245		263		944		690	
1899,	-	-	470	252	905	644	440		218		357		715		393	
1900,	-	-	498	361	1,758	1,071	645		365		390		980		437	
1901,	-	-	337	225	992	702	336		149		244		450		705	
1902,	-	-	590	402	1,071	730	627		204		550		588		198	
1903,	-	-	549	388	931	795	459		169		323		231		327	
1904,	313	-	517	376	663	542	475		174		153		106		375	
1905,	769	592	644	502	1,255	503	535		158		289		240		147	
1906,	446	272	953	714	1,407	1,143	692		205		431		475		1,279	
1907,	425	212	513	419	1,123	1,290	413		725		603		516		708	
1908,	731	466	850	885	1,559	1,241	932				426		387		445	
1909,	2,151	1,937	2,474	2,513	1,142	1,198	2,372		610		592		457		397	
1910,	480	328	464	556	928	1,033	455		436		426		354		154	
1911,	649	368	990	988	1,942	2,216	1,140		241		665		516		390	
1912,	585	368	939	882	4,682	7,873	888		253		327		298		494	
1913,	449	270	553	541	4,964	7,322	560		-		450		325		89	
1914,	753	309	735	692	2,036	4,189	532		-		425		347		625	
1915,	519	356	1,005	828	1,900	3,213	701		-		425		148		-	
1916,	922	550	930	992	2,708	1,949	837		-		-		-		-	
1917,	296	240	658	589	1,670	2,216	663		-		-		-		-	
1918,	229	132	475	332	3,492	2,800	455		-		-		-		-	

See note at end of this table.

TABLE No. 33. — *Microscopic Organisms in Water, etc.* — Concluded.

[Standard units per cubic centimeter; averages from weekly or biweekly observations.]

YEAR.	WESTON RESERVOIR.		SPOT POND.		CHESTNUT HILL RESERVOIR.				TAPS.				
	Surface.	Surface.	Surface.	Surface.	SUDBURY AQUEDUCT.		COCHITUATE AQUEDUCT.		EFFLUENT GATE-HOUSE.	Southern Low Service.	Southern High Service.	Northern Low Service.	Northern High Service.
					Inlet.	Inlet.	No. 2.						
1898,	485	304	544	304	230	-	-	-	-
1899,	1,129	329	992	192	201	-	-	-	-
1900,	573	568	1,139	897	468	452	-	-	-
1901,	628	344	697	413	243	280	-	-	-
1902,	581	563	937	525	367	451	-	-	-
1903,	650	450	860	435	286	398	-	-	-
1904,	465	405	838	472	303	470	274	189	388
1905,	609	551	904	554	528	671	363	326	422
1906,	671	631	1,042	721	550	583	326	205	422
1907,	443	349	909	419	427	422	443	1,313	677
1908,	979	741	1,073	689	666	695	443	221	374
1909,	2,399	1,999	632	1,899	1,913	1,959	1,313	349	461
1910,	625	457	-	465	447	421	221	412	462
1911,	748	700	1,382	735	778	967	412	237	356
1912,	1,117	855	3,887	919	1,035	410	249	412	419
1913,	607	535	2,622	850	603	549	262	409	520
1914,	648	492	-	540	631	601	352	294	217
1915,	656	643	-	601	872	858	409	352	294
1916,	811	842	-	1,041	569	534	251	461	462
1917,	446	598	638	717	569	534	352	294	217
1918,	347	417	2,766	521	390	485	251	461	462

NOTE. — A large growth of *Asterionella* originated in the Wachusett Reservoir in 1909, causing the large number of organisms in the water of Sudbury Reservoir and Framingham Reservoir No. 3, Weston and Chestnut Hill reservoirs, Spot Pond and in the water drawn from taps.

TABLE NO. 34. — *Number of Bacteria per Cubic Centimeter in Water from Various Parts of the Metropolitan Water Works, from 1898 to 1918, inclusive.*

[Averages of weekly determinations.]

YEAR.	CHESTNUT HILL RESERVOIR.			SOUTHERN SERVICE TAPS.	
	Sudbury Aqueduct Terminal Chamber.	Cochituate Aqueduct.	Effluent Gate-house No. 2.	Low Service, 180 Boylston Street.	High Service, 1 Ashburton Place.
1898,	207	145	111	96	-
1899,	224	104	217	117	123
1900,	248	113	256	188	181
1901,	225	149	169	162	168
1902,	203	168	121	164	246
1903,	76	120	96	126	243
1904,	347	172	220	176	355
1905,	495	396	489	231	442
1906,	231	145	246	154	261
1907,	147	246	118	130	176
1908,	162	138	137	136	148
1909,	198	229	119	150	195
1910,	216	-	180	178	213
1911,	205	204	151	175	197
1912,	429	450	227	249	259
1913,	123	243	157	119	140
1914,	288	-	252	174	220
1915,	163	-	128	117	134
1916,	128	-	85	102	105
1917,	178	112	119	119	141
1918,	1,163	168	705	317	544

TABLE No. 35. — *Colors of Water from Various Parts of the Metropolitan Water Works in 1918. (Averages of Weekly Determinations.)*
 [Platinum Standard.]

MONTH.	WACHSSETT RESERVOIR.				SUDBURY RESERVOIR.				LAKE COCHITUATE.			CHESTNUT HILL RESERVOIR.			SPOT POND.	FELLS RESERVOIR.	NORTHERN SERVICE.		SOUTHERN SERVICE.	
	Surface.	Mid-depth.	Bottom.	End of Open Channel.	Surface.	Mid-depth.	Bottom.	Mid-depth.	Surface.	Mid-depth.	Bottom.	Inlet (Sudbury Aqueduct).	Inlet (Cochituate Aqueduct).	Effluent Gate-house No. 2.			Tap at Glenwood Yard, Medford (Low Service).	Tap at Fire Station, Hancock Street, Everett (High Service).	Tap at 180 Boylston Street, Boston (Low Service).	Tap at 1 Ashburton Place, Boston (High Service).
January,	11	11	11	11	15	16	15	15	16	17	17	15	14	14	8	6	14	14	14	14
February,	9	9	9	11	12	12	11	13	26	18	15	14	14	12	7	5	12	13	13	13
March,	15	18	11	17	12	12	17	17	17	18	18	17	16	16	9	6	14	14	14	14
April,	11	9	12	17	17	15	17	15	17	18	18	16	16	16	9	6	14	14	14	14
May,	11	12	12	16	16	16	16	14	17	18	14	15	14	16	8	6	16	16	16	16
June,	11	12	12	15	15	16	14	14	17	18	14	15	14	16	8	6	15	17	14	15
July,	10	11	12	12	13	16	24	21	13	16	14	12	12	11	8	5	12	14	14	15
August,	9	11	11	12	10	11	13	16	11	17	21	10	10	9	6	5	10	10	10	10
September,	8	9	9	9	9	14	16	62	11	16	62	10	10	9	7	5	11	6	11	12
October,	10	11	11	14	15	13	16	79	13	16	79	13	12	12	9	8	11	10	12	13
November,	12	11	14	15	15	15	15	78	15	15	78	15	15	14	10	8	13	12	15	15
December,	10	10	11	15	15	16	16	16	16	16	16	15	15	14	8	8	14	14	14	14
Averages,	11	11	11	14	14	14	14	16	16	16	37	14	16	13	8	7	13	7	13	14

TABLE No. 36. — *Temperatures of Water from Various Parts of the Metropolitan Water Works in 1918. (Averages of Weekly Determinations.)*

[The temperatures are taken at the same places and times as the samples for microscopical examination; the depth given for each reservoir is the depth from high-water mark.]

[Degrees Fahrenheit.]

MONTH.	WACHUSETT ¹ RESERVOIR (DEPTH AT PLACE OF OBSERVATION 107 FEET).			SUDBURY ¹ RESERVOIR (DEPTH AT PLACE OF OBSERVATION 54.5 FEET).			WACHU- SETT AQUE- DUCT.			FRAMINGHAM ¹ RESERVOIR No. 3 (DEPTH AT PLACE OF OBSERVATION 20.5 FEET).			LAKE COCHITUATE ¹ (DEPTH AT PLACE OF OBSERVATION 62.0 FEET).			CHEST- NUT HILL RESER- VOIR.			SPOT POND ¹ (DEPTH AT PLACE OF OBSERVATION 28.0 FEET).			NORTHERN SERVICE.		SOUTHERN SERVICE.	
	Surface.	Mid-depth.	Bottom.	Surface.	Mid-depth.	Bottom.	End of Open Channel.	Surface.	Mid-depth.	Bottom.	Surface.	Mid-depth.	Bottom.	Surface.	Mid-depth.	Bottom.	Effluent Gate-house No. 2.	Surface.	Mid-depth.	Bottom.	Tap at Glenwood Yard, Medford (Low Service).	Tap at Fire Station, Hancock Street, Ply- mouth (High Service).	Tap at 180 Boylston Street, Boston (Low Service).	Tap at 1 Ashburton Place, Boston (High Service).	
January, .	34.4	34.7	37.5	32.9	35.5	36.0	33.8	34.3	34.9	34.4	35.3	36.7	37.0	35.4	36.5	36.0	35.4	35.3	36.5	36.0	37.2	37.2	37.5	41.4	
February, .	35.8	36.5	36.7	34.2	35.3	36.5	34.0	34.3	33.9	35.4	35.4	35.9	35.9	35.1	36.0	38.0	35.1	36.0	35.9	38.0	36.3	38.0	36.2	38.4	
March, .	35.8	36.3	37.3	35.8	36.0	37.0	35.3	36.5	36.6	35.2	36.9	—	—	35.7	43.9	44.1	41.4	43.9	45.5	44.1	44.0	38.7	37.7	38.6	
April, .	40.8	41.1	39.3	44.4	44.0	43.0	41.5	52.8	52.6	60.6	63.4	43.2	41.6	41.4	43.9	45.5	44.1	43.9	45.5	44.1	44.0	62.7	61.8	67.8	
May, .	58.9	56.0	49.3	62.6	63.0	58.5	58.5	64.5	64.5	60.6	63.4	47.4	45.5	61.7	60.7	62.3	66.4	67.3	66.8	68.2	59.0	62.7	67.4	67.8	
June, .	64.4	60.0	50.3	67.9	65.0	61.5	54.0	67.3	66.5	65.9	67.7	48.7	45.7	67.5	67.3	66.4	68.5	72.1	69.8	68.2	68.6	69.3	70.7	71.3	
July, .	71.3	60.0	53.5	73.5	70.8	68.3	57.0	73.7	71.3	69.2	73.4	50.1	46.7	71.0	72.2	72.5	72.9	73.2	72.5	70.5	71.8	71.8	73.3	73.5	
August, .	73.0	56.8	50.5	73.6	70.8	68.3	59.5	72.9	72.7	72.5	66.6	51.0	47.9	67.8	68.0	66.5	67.8	67.3	68.0	66.5	69.0	68.0	68.7	69.7	
September, .	67.3	65.3	53.8	67.5	68.3	66.0	65.5	56.5	56.4	54.9	57.2	44.0	46.5	67.8	67.3	66.5	67.8	67.3	68.0	66.5	69.8	68.7	58.7	59.7	
October, .	57.5	57.5	53.2	57.4	57.6	57.3	44.6	55.5	56.5	54.9	49.7	44.0	46.5	57.5	57.1	56.9	57.5	49.9	48.8	52.0	59.8	59.2	51.5	53.1	
November, .	50.9	52.5	49.3	49.8	50.0	51.5	44.6	47.5	44.7	51.0	49.7	49.6	46.0	50.5	49.9	48.5	50.5	51.1	51.5	54.7	54.7	51.5	51.7	53.1	
December, .	40.4	40.0	40.5	35.6	36.3	38.7	35.3	36.3	36.0	36.9	38.6	39.1	40.3	37.5	37.1	37.0	37.5	37.1	37.0	38.1	42.0	39.4	40.8	41.8	
Averages, .	52.6	49.7	45.9	52.9	52.4	51.6	47.9	53.6	53.0	51.6	52.0	45.0	43.6	53.1	53.1	52.4	53.7	53.1	53.1	52.4	53.7	53.9	54.1	55.3	

¹ Surface temperatures are averages of weekly determinations. Mid-depth and bottom temperatures are averages of biweekly determinations.

TABLE NO. 37. — *Temperatures of the Air at Three Stations on the Metropolitan Water Works in 1918.*

[Degrees Fahrenheit.]

MONTH.	CHESTNUT HILL RESERVOIR.			FRAMINGHAM.			CLINTON.		
	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.
January,	50	—3	22.2	48	—6	18.4	49	—7	16.9
February,	56	—14	29.9	55	—14	24.9	54	—16	23.2
March,	67	—1	—1	66	1	36.5	63	—	34.9
April,	78	19	44.2	78	27	47.8	72	27	38.6
May,	89	32	60.6	88	37	64.3	86	38	61.9
June,	93	37	62.1	93	37	65.0	86	41	62.0
July,	96	44	68.0	96	50	71.1	92	49	69.4
August,	95	41	68.3	95	44	72.0	93	44	69.6
September,	82	31	57.7	83	37	60.7	78	37	58.5
October,	78	25	53.5	79	29	55.2	77	31	53.5
November,	63	10	39.4	65	15	42.4	64	15	41.9
December,	60	4	29.1	59	10	32.1	57	6	31.5
Averages,	—	—	—	—	—	49.2	—	—	46.8

¹ Minimum thermometer out of order.

TABLE No. 38. — *Table showing Length of Main Lines of Water Pipes and Connections owned and operated by Metropolitan Water and Sewerage Board, and Number of Valves set in Same, Dec. 31, 1918.*

	DIAMETER OF PIPES IN INCHES.														Total.	
	60	48	42	40	36	30	24	20	16	14	12	10	8	6		4
Total length owned and operated Dec. 31, 1917 (feet).	43,802	211,092	9,810	6,989	61,787	49,771	85,492	76,059	67,856	26	26,546	3,829	1,878	994	33	645,964
Gate valves in same,	5	56	1	2	55	44	61	55	82	1	109	20	18	23	1	533
Air valves in same,	51	125	5	3	44	21	43	45	34	—	10	1	—	—	—	382
Length laid or relaid during 1918 (feet), .	—	—	—	—	6	12	914	9,698	539	—	67	—	—	—	—	11,236
Gate valves in same,	—	—	—	—	—	—	1	4	2	—	2	—	—	—	—	9
Air valves in same,	—	—	—	—	—	—	—	7	1	—	—	—	—	—	—	8
Length abandoned during 1918 (feet), .	—	—	—	—	6	12	910	38	28	—	50	—	—	—	—	1,044
Gate valves in same,	—	—	—	—	—	—	1	3	1	—	1	—	—	—	—	6
Air valves in same,	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	1
Length owned and operated Dec. 31, 1918 (feet).	43,802	211,092	9,810	6,989	61,787	49,771 ²	85,496	83,719	68,367	26	26,563	3,829	1,878	994	33	656,156 ³
Gate valves in same,	5	56	1	2	55	44	61	56	83	1	110	20	18	23	1	536
Air valves in same,	51	125	5	3	44	21	43	51	35	—	10	1	—	—	—	389

¹ Includes 2,035 feet of 76-inch concrete-lined pressure tunnel; 363 feet of 76-inch mortar-lined and concrete-covered steel pipe; 21 feet of 76-inch cast-iron pipe and 85 feet of 60-inch concrete-covered steel pipe.

² Includes 15,512 feet of 30-inch mortar-lined and covered wrought-iron pipe.

³ 124.27 miles.

TABLE No. 39. — *Statement of Cast-iron Hydrant, Blow off and Drain Pipes, owned and operated by Metropolitan Water and Sewerage Board, Dec. 31, 1918.*

	DIAMETER OF PIPES IN INCHES.								Total.
	24	20	16	12	10	8	6	4	
Total length in use Dec. 31, 1917 (feet),	352	292	3,121	6,861	176	513	3,515	1,472	16,302
Valves in same,	—	—	30	108	2	9	82	43	274
Length laid or relaid in 1918 (feet),	—	—	—	—	—	—	51	—	51
Valves in same,	—	—	—	—	—	—	3	—	3
Length abandoned in 1918 (feet),	—	—	—	—	—	—	—	—	—
Valves in same,	—	—	—	—	—	—	—	—	—
Total length in use Dec. 31, 1918 (feet),	352	292	3,121	6,861	176	513	3,566	1,472	16,353 ¹
Valves in same,	—	—	30	108	2	9	85	43	277

¹ 3.10 miles.

TABLE No. 40. — *Length of Water Pipes, Four Inches in Diameter and Larger, in the Several Cities and Towns supplied by the Metropolitan Water Works, Dec. 31, 1918.*

BY WHOM OWNED.	INCHES.												TOTALS.						
	60	48	42	40	36	30	24	20	18	16	14	12	10	8	7	6	4	Feet.	Miles.
Metropolitan Water Works,	43,802	211,092	9,810	6,989	61,787	49,771	85,496	85,719	—	68,367	26	26,563	3,829	1,878	—	994	33	656,156	124.27
Arlington,	—	—	—	—	—	—	—	—	—	—	—	24,136	28,621	40,209	—	145,884	15,611	254,461	48.19
Belmont,	—	—	—	—	—	—	—	—	—	—	—	5,714	16,954	26,557	—	113,212	269	162,706	30.82
Boston,	10,607	15,683	16,081	37,236	93,176	79,067	87,071	—	—	261,199	5,041	1,441,391	386,837	824,094	—	1,235,881	103,356	4,596,720	870.59
Chelsea,	—	—	—	—	—	—	—	—	—	5,176	—	5,479	39,826	30,268	—	143,240	6,656	230,645	43.68
Everett,	—	—	—	—	—	—	2,484	2,900	—	5,204	5,998	6,084	42,804	25,894	—	145,559	30,600	267,527	50.67
Lexington,	—	—	—	—	—	—	—	—	—	—	—	9,000	4,879	35,433	—	120,186	27,209	196,707	37.26
Malden,	—	—	—	—	—	—	—	—	—	6,773	9,179	83,017	31,276	86,594	—	223,552	50,967	491,358	93.06
Medford,	—	—	—	—	—	—	—	673	—	6,775	9,598	32,587	39,447	97,869	—	165,289	26,348	378,586	71.70
Melrose,	—	—	—	—	—	—	—	—	—	5,223	3,024	23,097	20,334	25,720	—	152,347	56,201	285,946	54.16
Milton,	—	—	—	—	—	—	—	—	—	103	44	22,556	20,926	53,687	—	156,114	17,177	270,607	51.25
Nahant,	—	—	—	—	—	—	—	—	—	—	4,000	150	11,550	4,800	—	36,800	59,208	116,508	22.07
Quincy,	—	—	—	—	—	—	2,679	—	—	23,232	—	29,125	44,321	139,931	994	377,066	96,305	713,653	135.16
Revere, ¹	—	—	—	—	—	—	—	—	—	23,813	6,970	24,077	28,037	34,640	—	103,224	71,808	292,619	55.42
Somerville,	—	—	—	—	—	—	—	—	—	4,210	367	7,950	92,254	57,049	108,010	—	214,264	510,229	96.63
Stonham,	—	—	—	—	—	—	—	—	—	—	—	7,425	1,825	5,110	—	107,809	18,425	140,594	26.63
Swampscott,	—	—	—	—	—	—	—	—	—	—	3,045	6,714	18,306	6,593	—	84,154	9,025	127,837	24.21
Watertown,	—	—	—	—	—	—	—	—	—	2,991	11,877	5,959	17,464	27,379	—	144,508	11,816	221,994	42.04
Winthrop,	—	—	—	—	—	—	—	—	—	—	—	4,049	24,073	34,652	—	55,025	55,847	173,646	32.89
Total feet,	43,802	221,699	25,493	23,070	99,023	142,947	167,047	183,252	367	412,991	66,752	1,849,377	838,358	1,609,368	994	3,725,108	678,851	10,088,499	—
Total miles,	8.30	41.99	4.83	4.37	18.75	27.07	31.64	34.71	0.07	78.22	12.64	350.26	158.78	304.80	0.19	705.51	128.57	—	1,910.70

¹ Includes small portion of Saugus.

TABLE NO. 41. — *Number of Service Pipes, Meters and Fire Hydrants in the Several Cities and Towns supplied by the Metropolitan Water Works, Dec. 31, 1918, and the Number of Services and Meters installed during the Year 1918.*

CITY OR TOWN.	Services.	Meters.	Fire Hydrants.	Services installed.	Meters installed.
Arlington,	3,171	3,171	502	68	68
Belmont,	1,755	1,755	248	28	28
Boston,	105,458	63,187	9,670	243	318
Chelsea,	5,194	5,184	401	18	19
Everett,	6,043	3,811	586	25	281
Lexington,	1,264	1,264	221	23	33
Malden,	8,192	7,970	610	66	114
Medford,	6,639	6,639	711	58	58
Melrose,	4,199	4,380	380	32	38
Milton,	2,055	2,055	440	29	29
Nahant,	737	557	101	9	9
Quincy,	10,248	9,270	1,207	287	164
Revere, ¹	4,754	3,661	304	47	58
Somerville,	13,514	10,116	1,239	23	121
Stoneham,	1,657	1,649	156	13	13
Swampscott,	1,954	1,954	200	32	32
Watertown,	3,184	3,191	415	52	52
Winthrop,	3,031	2,960	314	15	15
Totals,	183,049	132,774	17,705	1,068	1,450

¹ Includes small portion of Saugus.

TABLE No. 42. — *Average Elevation of the Hydraulic Grade Line, in Feet, above Boston City Base for Each Month at Stations on Metropolitan Water Works during 1918.*

1918. MONTH.	LOW SERVICE.										SOUTHERN HIGH SERVICE.								
	BOSTON ENGINE HOUSE, BULFINCH STREET.		ALLSTON ENGINE HOUSE, HARVARD STREET.		MEDFORD, MYSTIC RESERVOIR.		SOMERVILLE PUBLIC LIBRARY, HIGHLAND AVENUE.		MALDEN WATER WORKS SHOP, GREEN STREET.		CHELSEA COURT HOUSE.		BOSTON METROPOLITAN WATER WORKS OFFICE, 1 ASHBURTON PLACE.		WATERTOWN WATER WORKS OFFICE, MAIN STREET.		BELMONT WATER WORKS SHOP, WAYERLEY STREET.		
	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Maximum.	Minimum.	Maximum.	Maximum.	Minimum.	
January, .	146	138	176	173	163	160	164	161	163	160	161	161	153	243	228	257	235	254	237
February, .	146	136	180	177	165	162	166	163	160	163	160	161	152	243	225	246	219	246	222
March, .	154	143	182	179	170	166	-	-	166	162	166	166	157	246	228	252	224	250	226
April, .	152	140	181	173	169	164	-	-	166	163	166	166	158	249	230	257	232	253	232
May, .	150	138	178	172	168	163	-	-	167	163	166	166	157	248	229	254	220	252	226
June, .	150	139	178	172	167	163	-	-	167	163	166	166	157	245	228	253	212	255	220
July, .	150	139	181	172	167	161	170	165	167	163	166	166	156	246	228	249	209	252	217
August, .	151	141	179	172	168	163	167	163	167	162	167	167	157	245	228	245	206	249	217
September, .	150	142	177	168	167	164	170	165	166	162	165	165	155	245	228	246	212	251	222
October, .	152	141	178	169	167	162	168	164	166	162	163	163	154	247	229	250	215	252	224
November, .	154	145	180	170	167	162	168	164	167	162	165	165	153	247	230	256	238	254	236
December, .	153	143	178	168	167	162	169	164	166	162	164	164	154	246	228	260	251	256	244
Averages, .	151	140	179	172	167	163	168	164	166	162	165	165	155	246	228	252	223	252	227

TABLE No. 42. — *Average Elevation of the Hydraulic Grade Line, in feet, above Boston City Base, etc. — Concluded.*

1918. MONTH.	SOUTHERN HIGH SERVICE — Concluded.						NORTHERN HIGH SERVICE.									
	MILTON WATER WORKS OFFICE, ADAMS STREET.		FORBES HILL TOWER, QUINCY.		QUINCY WATER WORKS SHOP.		SOMERVILLE PUMPING STA- TION, CEDAR STREET.		MALDEN CITY HALL.		REVERE WATER WORKS OFFICE, BROADWAY.		LYNN ENGINE HOUSE, UNION SQUARE.		WINTHROP TOWN HALL, HERMAN STREET.	
	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Maximum.	Minimum.	Maximum.	Maximum.	Minimum.
January,	241	231	235	222	232	213	262	241	269	264	257	248	253	241	191	178
February,	239	228	232	218	225	204	259	232	268	264	247	238	239	227	184	171
March,	243	230	233	219	224	202	262	235	269	264	254	241	250	233	183	171
April,	247	234	238	224	232	210	266	241	270	265	259	248	256	240	190	174
May,	245	230	236	221	232	208	266	239	269	263	259	246	254	237	187	174
June,	243	229	234	218	230	205	266	239	269	262	257	241	243	223	187	171
July,	243	228	236	219	230	201	269	244	268	261	253	237	240	214	188	168
August,	242	228	235	219	229	200	268	246	267	263	254	236	244	218	187	170
September,	245	230	233	220	230	204	269	246	268	263	255	243	251	233	190	175
October,	245	231	233	220	230	205	268	246	269	264	260	250	256	244	192	180
November,	243	230	231	218	227	202	269	244	270	264	260	251	258	247	192	178
December,	243	230	230	218	227	204	269	246	270	264	262	253	260	249	194	180
Averages,	243	230	234	220	229	205	266	242	269	263	256	244	250	234	189	174

APPENDIX No. 3.

WATER WORKS STATISTICS FOR THE YEAR 1918.

The Metropolitan Water Works supply the Metropolitan Water District, which includes the following cities and towns: —

CITY OR TOWN.	Population, Census of 1915.	Estimated Population, July 1, 1918.
Arlington,	14,889	16,910
Belmont,	8,081	9,330
Boston,	745,439	790,330
Chelsea,	43,426	47,570
Everett,	37,718	40,700
Lexington,	5,538	5,900
Malden,	48,907	52,150
Medford,	30,509	34,600
Melrose,	16,880	17,870
Milton,	8,600	9,250
Nahant,	1,387	1,530
Newton, ¹	43,113	45,310
Quincy,	40,674	44,200
Revere,	25,178	29,350
Somerville,	86,854	92,930
Stoneham,	7,489	7,760
Swampscott,	7,345	7,960
Watertown,	16,515	18,520
Winthrop,	12,758	14,600
Total population of Metropolitan Water District, . . .	1,201,300	1,286,770
Saugus, ²	280	280

¹ No water supplied during the year from Metropolitan Water Works.

² Only a small portion of Saugus was supplied with water.

*Pumping.**Chestnut Hill Pumping Station No. 1: —*

Builders of pumping machinery, Holly Manufacturing Company, Quintard Iron Works and E. P. Allis Company.

Description of coal used:—Bituminous: 65 per cent. Ake Mine, Davenport and miscellaneous. Anthracite: screenings 35 per cent. Price per gross ton in bins: bituminous \$5.89 to \$12.17, screenings \$4.93 to \$4.98. Average price per gross ton \$7.26. Per cent. ashes 19.

Chestnut Hill Pumping Station No. 2:—

Builders of pumping machinery, Holly Manufacturing Company.

Description of coal used:—Bituminous: 55.8 per cent. Ake Mine, Davenport and miscellaneous. Anthracite: screenings 44.2 per cent. Price per gross ton in bins: bituminous \$5.73 to \$11.76, screenings \$4.60 to \$5.41. Average price per gross ton \$6.60. Per cent. ashes 24.1.

Spot Pond Station:—

Builders of pumping machinery, Geo. F. Blake Manufacturing Company and Holly Manufacturing Company.

Description of coal used:—Bituminous: 49.4 per cent. Davenport. Anthracite: screenings 50.6 per cent. Price per gross ton in bins: bituminous \$8.19 to \$11, screenings \$5.84 to \$6.25. Average price per gross ton \$7.44. Per cent. ashes 18.7.

Chestnut Hill Pumping Station No. 1.

	Engines Nos. 1 and 2.	Engine No. 3.	Engine No. 4.	Totals.
Daily pumping capacity (gallons),	16,000,000	20,000,000	30,000,000	66,000,000
Coal consumed for year (pounds),	—	—	—	4,294,757
Cost of pumping, figured on pumping station expenses,	—	—	—	\$31,507.94
Total pumpage for year, corrected for slip (million gallons),	1,538.29	—	234.80	1,823.09
Average dynamic head (feet),	132.94	—	124.05	131.55
Cost per million gallons raised to reservoir, . . .	—	—	—	\$17.2827
Cost per million foot gallons,	—	—	—	.1314

Chestnut Hill Pumping Station No. 2.

	Engines Nos. 5, 6 and 7.	Engine No. 12.	Totals.
Daily pumping capacity (gallons),	105,000,000	40,000,000	145,000,000
Coal consumed for year (pounds),	—	—	17,493,533
Cost of pumping, figured on pumping station expenses, .	—	—	\$99,512.92
Total pumpage for year, corrected for slip (million gallons),	13,351.75	13,872.21	27,223.96
Average dynamic head (feet),	36.26	122.44	80.17
Cost per million gallons raised to reservoir,	—	—	\$3.6553
Cost per million foot gallons,	—	—	.0456

Spot Pond Pumping Station.

	Engines Nos. 8 and 9.
Daily pumping capacity (gallons),	30,000,000
Coal consumed for year (pounds),	3,946,797
Cost of pumping, figured on pumping station expenses,	\$31,610.04
Total pumpage for year, corrected for slip (million gallons),	3,474.70
Average dynamic head (feet),	131.82
Cost per million gallons raised to reservoir,	\$9.0972
Cost per million foot gallons, . . . . .	.0690

Consumption.

Estimated total population of the eighteen cities and towns supplied wholly or partially during the year 1918,	1,241,460
Total consumption (gallons), meter basis,	47,363,860,000 ¹
Average daily consumption (gallons), meter basis,	129,764,000
Gallons per day to each inhabitant, meter basis,	104.5

Distribution.

	Owned and operated by Metropolitan Water and Sewerage Board.	Total in District supplied by Metropolitan Water Works.
Kinds of pipe used,	-2	-2
Sizes,	76-4 inch.	76-4 inch.
Extensions, less length abandoned (miles),	1.93	9.41
Length in use (miles),	124.27	1,910.70
Stop-gates added,	3	-
Stop-gates now in use,	536	-
Service pipes added,	-	1,068
Service pipes now in use,	-	183,049
Meters added,	-	1,450
Meters now in use,	-	132,774
Fire hydrants added,	-	162
Fire hydrants now in use,	-	17,705

¹ 67.86 per cent. pumped; 32.14 per cent. by gravity.² Cast-iron, cement-lined wrought-iron, cement-lined steel and kalamine pipe.

APPENDIX No. 4.

CONTRACTS MADE AND PENDING DURING

Contracts relating to the

1.	2.	3.	AMOUNT OF BID.		6.
			4.	5.	
Number of Contract.	WORK.	Number of Bids.	Next to Lowest.	Lowest.	Contractor.
1	144	Part of Section 76, Reading Extension, North Metropolitan System, in Wakefield and Reading.	-	-	Bruno & Petitti, Boston.

Contracts relating to the

1	138	Section 98, High-level sewer, Wellesley extension, South Metropolitan System in West Roxbury and Dedham.	3	\$79,040 00	\$54,630 00 ¹	Thomas Russo & Co., Boston.
2	139	Part of Section 99, High-level sewer, Wellesley extension, South Metropolitan System in Dedham.	3	93,070 00	92,870 00 ¹	Rowe Contracting Co., Boston.
3	143 ²	Section 102, High-level sewer, Wellesley extension, South Metropolitan System in Needham.	3	66,293 40	62,041 75 ¹	Bruno & Petitti, Boston.

¹ Contract based upon this bid.

APPENDIX NO. 4.

THE YEAR 1918 — SEWERAGE WORKS.

North Metropolitan System.

7. Date of Con- tract.	8. Date of Completion of Work.	9. Prices of Principal Items of Contracts made in 1918.	10. Value of Work done Dec. 31, 1918.	
July 29, 1918	-	- - -	\$20,979 84	1

South Metropolitan System.

July 13, 1916	-	Work abandoned by the Contractor before any portion was completed. Work provided for is now being completed in accordance with the specifications by Geo. M. Bryne.	\$208,334 73	1
June 7, 1918	-	For earth excavation and refilling in trench for 33-in. by 36-in. concrete sewer, \$30 per lin. ft.; for earth or rock excavation or both and refilling in tunnel for 33-in. by 36-in. concrete sewer, \$38 per lin. ft.; for Portland cement brick masonry in manholes, shafts and special structures, \$25 per cu. yd.; for Portland cement concrete masonry in trench and special structures, \$23 per cu. yd.; for Portland cement concrete masonry in tunnel, \$24 per cu. yd.; for rock excavation in trench, \$8 per cu. yd.	19,380 00	2
Oct. 2, 1916	May 1, 1918	- - -	67,953 81	3

² Contract completed.

CONTRACTS MADE AND PENDING DURING THE YEAR 1918 — SEWERAGE WORKS
— *Concluded.*

Summary of Contracts.

	Value of Work done Dec. 31, 1918.
North Metropolitan System, 1 contract,	\$20,979 84
South Metropolitan System, 3 contracts,	295,668 54
Total of 4 contracts made and pending during the year 1918,	\$316,648 38

APPENDIX No. 5.

FINANCIAL STATEMENT PRESENTED TO THE GENERAL COURT ON JANUARY 15, 1919.

The Metropolitan Water and Sewerage Board respectfully presents the following abstract of the account of its receipts, expenditures, disbursements, assets and liabilities for the year ending November 30, 1918, together with recommendations for legislation which it deems desirable, in accordance with the provisions of chapter 235 of the Acts of the year 1906.

METROPOLITAN WATER WORKS.

Construction.

The loans authorized for expenditures under the Metropolitan Water acts, the receipts which are added to the loan fund, the expenditures for the construction and acquisition of works, and the balance available on December 1, 1918, have been as follows: —

Loans authorized under Metropolitan Water acts, including appropriation under Gen. St. 1918, c. 177, to provide an additional water supply for the towns of Watertown and Belmont,	\$42,913,000 00
Receipts from town of Swampscott for admission to Metropolitan Water District, paid into Loan Fund (St. 1909, c. 320),	90,000 00
Receipts from the sales of property which are placed to the credit of the Metropolitan Water Loan Fund: —	
For the year ending November 30, 1918,	\$3,495 78
For the period prior to December 1, 1917,	253,647 64
	257,143 42
	\$43,260,143 42
Amount approved for payment by the Board out of the Metropolitan Water Loan Fund: —	
For the year ending November 30, 1918,	\$172,902 31
For the period prior to December 1, 1917,	42,980,841 25
	43,153,743 56
Balance December 1, 1918,	\$106,399 86

The amount of the Metropolitan Water Loan bonds issued at the end of the fiscal year was \$42,752,000, no additional bonds having been issued during the year. Of the total amount issued, \$41,398,000 were sinking fund bonds, and the remainder, amounting to \$1,354,000, were issued as serial bonds.

At the end of the year the amount of outstanding bonds was \$42,611,000, as bonds issued on the serial payment plan to the amount of \$141,000 had been paid. During the fiscal year \$37,000 in serial bonds have been paid.

The Metropolitan Water Loan Sinking Fund amounted on December 1, 1918, to \$14,870,834.84, an increase during the year of \$834,555.96.

Maintenance.

Amount appropriated for the maintenance and operation of works for the year ending November 30, 1918,	\$601,500 00	
Special appropriation for protection of water supply in aqueducts (1911) remaining,	9,930 60	
Special appropriations for protection and improvement of the water supply (1912, 1913 and 1916) remaining,	10,304 36	
Receipts credited to this fund for the year ending November 30, 1918,	3,430 09	
	<hr/>	\$625,165 05
Amount approved by Board for maintenance and operation of works during the year ending November 30, 1918,	\$588,784 60	
Deduct amount paid from appropriation for year 1917,	28,858 41	
	<hr/>	559,926 19
Balance December 1, 1918,		\$65,238 86

This balance includes the sum of \$9,930.60, the amount remaining unexpended of the special appropriation for the protection of the water supply in aqueducts, and the sums of \$2,713.93, the amount remaining unexpended of the special appropriation in 1912, \$39.45 of the special appropriation in 1913, \$6,160.54 of the special appropriation in 1916 and \$20,000 of the appropriation in 1918 for the protection and improvement of the water supply.

The Board has also received during the year ending November 30, 1918, \$92,271.66 from rentals, the sale of land, land products and power and from other proceeds from the operations of the Board,

which, according to section 18 of the Metropolitan Water Act, are applied by the Treasurer of the Commonwealth to the payment of interest on the Metropolitan Water Loan, to sinking fund requirements, and expenses of maintenance and operation of works, in reduction of the amount to be assessed upon the Metropolitan Water District for the year.

Sums received from sales of water to municipalities not belonging to the District and to water companies, and from municipalities for admission to the District, have been applied as follows: —

For the period prior to December 1, 1906, distributed to the cities and towns of the District, as provided by section 3 of the Metropolitan Water Act,	\$219,865 65
For the period beginning December 1, 1906, and prior to December 1, 1917, applied to the Metropolitan Water Loan Sinking Fund, as provided by chapter 238 of the Acts of 1907,	76,800 42
For the year beginning December 1, 1917, and ending November 30, 1918, applied to the Metropolitan Water Loan Sinking Fund, as provided by said last-named act,	11,838 14
	<hr/>
	\$308,504 21

METROPOLITAN SEWERAGE WORKS.

Construction.

The loans authorized under the various acts of the Legislature for the construction of the Metropolitan Sewerage Works, the receipts which are added to the proceeds of the loans, and the expenditures for construction, are given below, as follows: —

North Metropolitan System.

Loans authorized for expenditures for construction under the various acts, including those for the Revere, Belmont and Malden extensions, North System enlargements and extensions, New Mystic Sewer, Deer Island outfall extension, lowering sewer siphon under Malden River, balance of appropriation under chapter 76, Resolves of 1915, and for the Reading extension,	\$7,512,365 73
Receipts from sales of real estate and from miscellaneous sources, which are placed to the credit of the North Metropolitan System: —	
For the year ending November 30, 1918,	244 73
For the period prior to December 1, 1917,	85,776 46
	<hr/>
Amount carried forward,	\$7,598,386 92

Amount brought forward, \$7,598,386 92

Amount approved for payment by the Board¹
out of the Metropolitan Sewerage Loan Fund,
North System: —

For the year ending November 30, 1918, .	\$39,887 58
For the period prior to December 1, 1917, .	7,284,364 36
	<hr/>
	\$7,598,386 92

\$7,324,251 94

Balance December 1, 1918,	\$274,134 98
-------------------------------------	--------------

South Metropolitan System.

Loans authorized for expenditures for construction under the various acts, applied to the construction of the Charles River valley sewer, Neponset valley sewer, High-level sewer and extensions (including Wellesley Branch), and an additional appropriation authorized by chapter 285, General Acts of 1917, and for additional Ward Street station pumping plant, . \$9,587,046 27

Receipts for pumping, sales of real estate and from miscellaneous sources, which are placed to the credit of the South Metropolitan System: —

For the year ending November 30, 1918, .	31 10
For the period prior to December 1, 1917, .	19,383 93

Amount approved by Board for payment as follows: —

On account of the Charles River valley sewer,	\$800,046 27
On account of the Neponset valley sewer,	911,531 46
On account of the High-level sewer and extensions: —	
For the year ending November 30, 1918,	125,402 88
For the period prior to December 1, 1917,	7,633,190 03
	<hr/>
	\$9,606,461 30

\$9,470,170 64

Balance December 1, 1918,	\$136,290 66
-------------------------------------	--------------

The amount of the Metropolitan Sewerage Loan bonds issued at the end of the fiscal year was \$17,086,412, bonds to the amount of \$325,000 having been issued during the year. Of the total amount

¹ The word "Board" refers to the Metropolitan Sewerage Commission and its successor, the Metropolitan Water and Sewerage Board.

issued, \$15,440,912 were sinking fund bonds, and the remainder, amounting to \$1,645,500, were serial bonds.

At the end of the year the amount of the outstanding bonds was \$16,617,912, as bonds issued on the serial payment plan to the amount of \$47,500 had been paid during the year, \$143,500 having been paid to December 1, 1918.

Of the total amount outstanding at the end of the year, \$7,387,000 were issued for the North Metropolitan System and \$9,555,912 for the South Metropolitan System. The Metropolitan Sewerage Loan Sinking Fund amounted on December 1, 1918, to \$4,270,205.50, of which \$2,690,491.90 were on account of the North Metropolitan System and \$1,579,713.60 were on account of the South Metropolitan System, an increase during the year of \$344,412.75.

The net debt on December 1, 1918, was \$12,672,706.50, a decrease of \$66,912.75.

Included in the above figures for the North Metropolitan System are \$925,000 in serial bonds, of which \$101,500 have been paid, and \$720,000 for the South Metropolitan System, of which \$42,000 have been paid.

Maintenance.

North Metropolitan System.

Appropriated for the year ending November 30, 1918,	\$235,700 00
Receipts from pumping and from other sources, which are returned to the appropriation:—	

For the year ending November 30, 1918,	682 43
	\$236,382 43

Amount approved for payment by the Board:—

For the year ending November 30, 1918,	230,365 79
--	------------

Balance December 1, 1918,	\$6,016 64
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South Metropolitan System.

Appropriated for the year ending November 30, 1918,	\$145,860 00
Receipts from sales of property, reimbursement and for pumping, which are returned to the appropriation:—	

For the year ending November 30, 1918,	10,746 63
	\$156,606 63

Amount approved for payment by the Board:—

For the year ending November 30, 1918,	149,253 09
--	------------

Balance December 1, 1918,	\$7,353 54
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APPENDIX No. 6.

LEGISLATION OF THE YEAR 1918 AFFECTING THE
METROPOLITAN WATER AND SEWERAGE BOARD.

General Acts, 1918.

CHAPTER 3.

AN ACT RELATIVE TO THE INTEREST ON BONDS ISSUED FOR
THE CONSTRUCTION OF A POWER TRANSMISSION LINE
BETWEEN THE WACHUSETT DAM AND THE SUDBURY
DAM.

Be it enacted, etc., as follows:

1917, 287 (G),
§ 1, amended.

SECTION 1. Section one of chapter two hundred and eighty-seven of the General Acts of the year nineteen hundred and seventeen is hereby amended by striking out the words "Act of 1917", in the tenth and eleventh lines, and adding at the end thereof the words: — except that the rate of interest to be paid thereon shall be such as the treasurer and receiver general, with the approval of the governor and council, may determine, — so as to read as follows: —

Rate of interest
on bonds for
power trans-
mission line
between Wa-
chusett and
Sudbury dams.

Section 1. To enable the metropolitan water and sewerage board to construct a line for the transmission of electricity between the power station at the Wachusett dam in Clinton and the power station at the Sudbury dam in Southborough, under authority of chapter one hundred and seventy-two of the General Acts of the year nineteen hundred and sixteen, the treasurer and receiver general shall issue from time to time, upon the request of said board, bonds in the name and behalf of the commonwealth, designated on the face thereof, Metropolitan Water Loan, to an amount not exceeding twelve thousand dollars, to be taken from the unexpended balance of forty-six thousand dollars authorized by chapter six hundred and ninety-four of the acts of the year nineteen hundred and twelve; and the provisions of chapter four hundred and eighty-eight of the acts of the year eighteen hundred and ninety-five, and

of acts in amendment thereof and in addition thereto, shall, so far as they may be applicable, apply to the indebtedness and proceedings authorized by this act, except that the rate of interest to be paid thereon shall be such as the treasurer and receiver general, with the approval of the governor and council, may determine.

SECTION 2. This act shall take effect upon its passage.
[Approved February 7, 1918.]

CHAPTER 5.

AN ACT RELATIVE TO THE INTEREST ON BONDS ISSUED FOR
THE CONSTRUCTION OF A WATER MAIN IN THE EAST
BOSTON DISTRICT OF THE CITY OF BOSTON.

Be it enacted, etc., as follows:

SECTION 1. Section two of chapter three hundred and twenty-two of the General Acts of the year nineteen hundred and seventeen is hereby amended by striking out the words "Act of 1917", in the sixth line, and adding at the end thereof the words:—except that the rate of interest to be paid thereon shall be such as the treasurer and receiver general, with the approval of the governor and council, may determine,—so as to read as follows:—

1917, 322 (G),
§ 2, amended.

Section 2. To meet the expenses incurred under the provisions of this act, the treasurer and receiver general shall issue from time to time, upon the request of said board, bonds in the name and behalf of the commonwealth and under its seal, designated on the face thereof Metropolitan Water Loan, to an amount not exceeding thirty thousand dollars, to be taken from the unexpended balance of the amount authorized by chapter six hundred and ninety-four of the acts of the year nineteen hundred and twelve, and the provisions of chapter four hundred and eighty-eight of the acts of the year eighteen hundred and ninety-five, and acts in amendment thereof and in addition thereto, shall, so far as applicable, apply to the indebtedness and proceedings authorized by this act, except that the rate of interest to be paid thereon shall be such as the treasurer and receiver general, with the approval of the governor and council, may determine.

Rate of interest
on bonds for
water main to
East Boston.

SECTION 2. This act shall take effect upon its passage.
[Approved February 7, 1918.]

CHAPTER 6.

AN ACT RELATIVE TO THE INTEREST ON BONDS ISSUED FOR
COMPLETING THE EXTENSION OF THE SOUTH METROPOL-
ITAN SEWER TO THE TOWN OF WELLESLEY.*Be it enacted, etc., as follows:*1917, 285 (G),
§ 1, amended.Rate of interest
on bonds for
completing
sewer extension
to town of
Wellesley.

SECTION 1. Section one of chapter two hundred and eighty-five of the General Acts of the year nineteen hundred and seventeen is hereby amended by adding at the end thereof the words: — except that the rate of interest to be paid thereon shall be such as the treasurer and receiver general, with the approval of the governor and council, may determine, — so as to read as follows: — *Section 1.* The treasurer and receiver general, in order to provide for the completion of the extension of the high-level sewer authorized by chapter three hundred and forty-three of the acts of the year nineteen hundred and fourteen, shall, with the approval of the governor and council, issue from time to time scrip or certificates of indebtedness in the name and behalf of the commonwealth and under its seal, to an amount not exceeding three hundred and twenty-five thousand dollars, in addition to the amount authorized by said chapter; and the provisions of said chapter and of chapter four hundred and twenty-four of the acts of the year eighteen hundred and ninety-nine, and of all acts in amendment thereof and in addition thereto shall, so far as they may be applicable, apply to the indebtedness and proceedings authorized by this act, except that the rate of interest to be paid thereon shall be such as the treasurer and receiver general, with the approval of the governor and council, may determine.

SECTION 2. This act shall take effect upon its passage.
[Approved February 7, 1918.]

CHAPTER 157.

AN ACT TO PROVIDE FOR THE COMPLETION OF CERTAIN
AUTHORIZED IMPROVEMENTS IN THE METROPOLITAN
WATER WORKS.*Be it enacted, etc., as follows:*Completion of
certain author-
ized improve-
ments in the
metropolitan
water works.

The treasurer and receiver general, in order to provide for the increased cost of constructing a line for the transmission of electricity between the power station at the

Wachusett dam in Clinton and the power station at the Sudbury dam in Southborough, to relocate and connect meters for the measuring of water supplied through the low service to the metropolitan water district, to construct a 12-inch pipe line in Poplar street, West Roxbury, and under the Neponset river, and to install a new pumping engine at the Arlington pumping station, all of which improvements were authorized by chapter one hundred and seventy-two of the General Acts of nineteen hundred and sixteen, shall issue from time to time, upon the request of the metropolitan water and sewerage board, bonds in the name and behalf of the commonwealth and under its seal, to an amount not exceeding four thousand dollars, said sum being the amount of the unexpended balance of six hundred thousand dollars authorized by chapter six hundred and ninety-four of the acts of nineteen hundred and twelve. *[Approved April 20, 1918.]*

CHAPTER 177.

AN ACT TO AUTHORIZE THE METROPOLITAN WATER AND SEWERAGE BOARD TO PROVIDE AN ADDITIONAL WATER SUPPLY FOR THE TOWNS OF WATERTOWN AND BELMONT.

Be it enacted, etc., as follows:

SECTION 1. The metropolitan water and sewerage board is hereby authorized to provide an additional water supply from the southern high service of the metropolitan water system for the towns of Watertown and Belmont, and to construct such mains, pipe lines, conduits and works as may be necessary therefor.

Additional
water supply
for Watertown
and Belmont.

SECTION 2. To meet expenses incurred hereunder, the treasurer and receiver general shall, from time to time, issue, upon the request of said board, bonds in the name and behalf of the commonwealth to an amount not exceeding one hundred and fifteen thousand dollars in addition to the sum of forty-two million seven hundred and ninety-eight thousand dollars authorized by chapter four hundred and eighty-eight of the acts of eighteen hundred and ninety-five and acts in amendment thereof and in addition thereto, and the provisions of said chapter and acts shall apply to the loan hereby authorized.

Issue of bonds
to meet
expenses, etc.

SECTION 3. This act shall take effect upon its passage. *[Approved April 26, 1918.]*

Special Act, 1918.

CHAPTER 45.

AN ACT RELATIVE TO THE INSTALLATION OF WATER METERS
IN THE CITY OF BOSTON.*Be it enacted, etc., as follows:*

City of Boston,
installation of
water meters
deferred.

SECTION 1. The provisions of section one of chapter five hundred and twenty-four of the acts of nineteen hundred and seven shall not apply to the city of Boston for one year after the taking effect of this act, in so far as the same require the equipment with water meters of five per cent of water services in said city which were unmetered on the thirty-first day of December, nineteen hundred and seven.

Time of taking
effect.

SECTION 2. This act shall take effect upon the tenth day of April, nineteen hundred and eighteen. [*Approved February 25, 1918.*]

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M.

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METROPOLITAN WATER AND SEWERAGE BOARD.

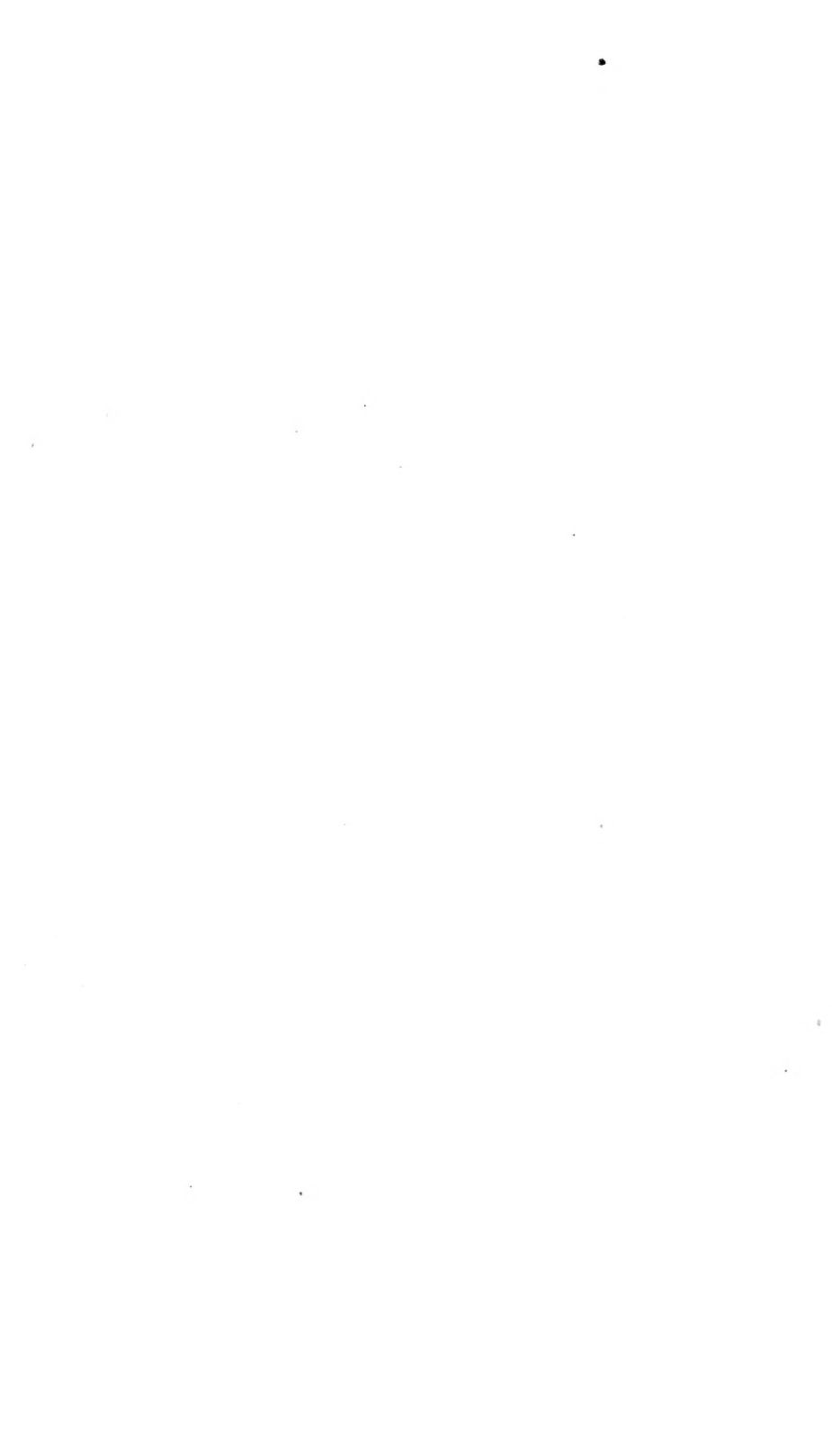
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WATERTOWN.

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